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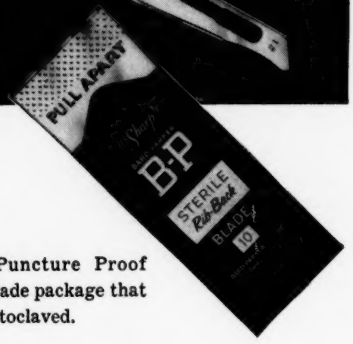

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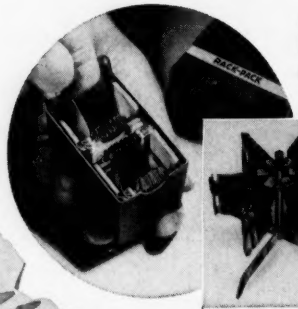

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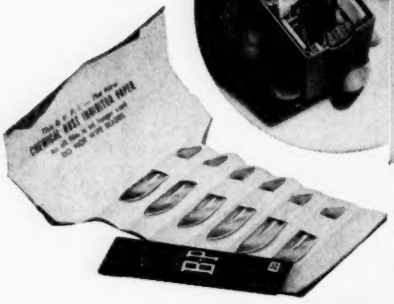

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General Surgery

Incarcerated and Strangulated Femoral Hernia

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FEMORAL hernia does not occur frequently.[1] The importance of this condition lies in the errors commonly made in its diagnosis when it does occur.

This report concerns observations on 125 patients with femoral hernia, cared for at a private hospital during a twelve-year period, and is presented with the hope that the data recorded will interest those called upon to treat this condition. Fifty of these cases were reviewed in 1950.[2]

Thirty-three of the 125 patients were men—a male-female ratio of approximately 1 to 4. Only 21 of the 125 men were under 40 years of age, while 45 were over 60. This is significant, because elderly patients frequently acquire a variety of abdominal complaints that may be attributed to an intra-abdominal lesion, while a significant femoral hernia is overlooked in spite of incarceration or strangulation. There were 93 hernias on the right side and 29 on the left, and in 3 instances the condition was bilateral. It is likely that the sigmoid portion of the colon, overlying the femoral space, plays a role in preventing the more frequent development of hernia on the left side (Table 1).

Table 2 is especially significant. It concerns the relation between inguinal and femoral hernia. Most commonly the femoral hernia is *mistaken* for an inguinal hernia, and the effort at repair is misdirected.[3] In this series it was observed in 7 instances (Table 2*A*).

The importance of physical examination in distinguishing between the two must

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be emphasized. In the majority of instances, examination of the patient in the standing position makes the distinction obvious on inspection. On palpation the mass of the femoral hernia is lateral to the pubic spine. The sac of the femoral hernia is made up of three layers (Fig. 1, *A* and *B*). The outer layer is composed of fascia derived from the femoral sheath and varies considerably in thickness. This layer is usually so much thinned that it forms but a transparent surface envelope. The inner layer is derived from the peritoneum and represents an outpouching

TABLE 1.—*Data on 125 Cases*

Age	*Number*	*Male*	*Female*	*R*	*L*	*Bilateral*	*Surgically Treated*	*Deaths*	*Medically Treated*	*Deaths*
5-19	4	1	3	3	1	0	4		0	
20-29	7	1	6	6	1	0	7		0	
30-39	10	2	8	8	2	0	9		1	
40-49	24	5	19	19	5	0	24		0	
50-59	35	10	25	27	7	1	36		0	
60-69	26	9	17	17	8	1	25		2	1
70-79	19	5	14	13	5	1	19	1	1	1
Total	125	33	92	93	29	3	124	1	4	2

TABLE 2.—*Relation Between Inguinal and Femoral Hernias*

A. *Operation for Inguinal Hernia, Failure to Note Femoral Hernia*

Case	*Age of Patient*	*Sex of Patient*	*Previous Operation*	*Femoral Hernia Noted*
1	22	F	1 yr.	Immediately
2	50	M	9 yr.	Immediately
3	39	M	9 mo.	Immediately
4	63	M	2 mo.	Soon after
5	38	F	1 yr.	Two weeks
6	41	M	3 wk.	Two weeks
7	31	M	2 yr.	Immediately
8	46	F	3 wk.	Immediately

B. *Operation for Inguinal Hernia; Unrelated to Femoral Hernia*

1	54	M	20 yr.	Years later
2	60	M	14 yr.	Years later

C. *Operation on Groin for Inguinal and Femoral Hernias*

1	54	M	0	Right inguinal pantaloon hernia and right femoral hernia
2	69	M	0	Bilateral femoral hernia and left indirect inguinal hernia

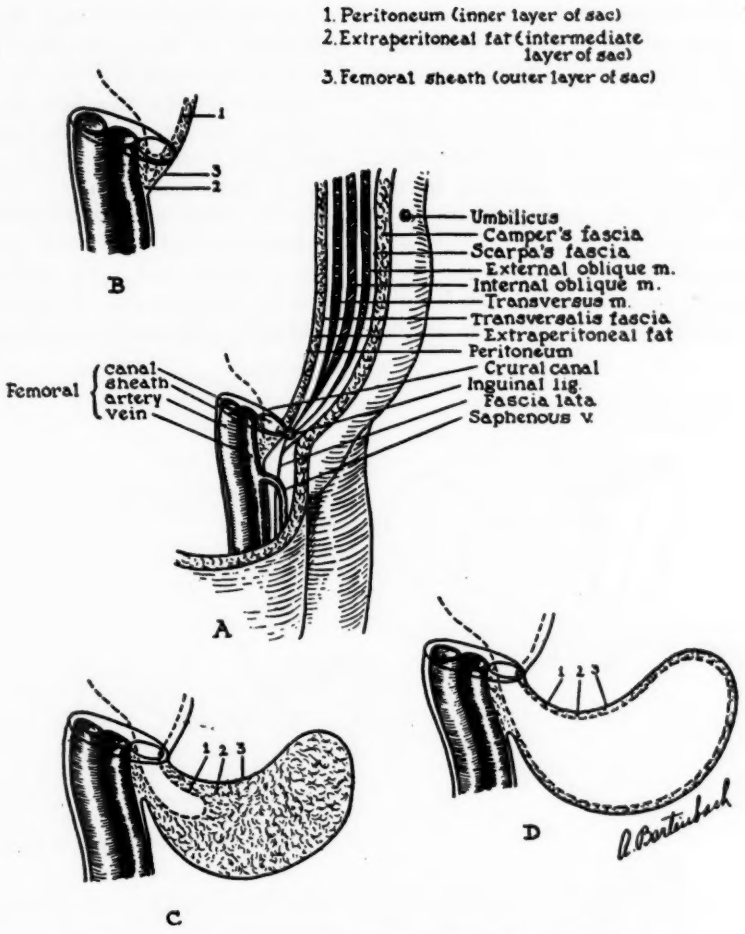

Fig. 1.—*A* and *B*, composition of femoral hernia sac (see text); *C*, thick-walled sac; *D*, thin-walled sac (see text).

into the femoral canal. The intermediate layer is composed of fat derived from the extraperitoneal fatty layer. This layer also varies considerably. The femoral hernia sac may be exceedingly thick-walled, owing to a rich investment of fat in this layer (Fig. 1*C*), while in other instances it may be exceptionally thin-walled because of the paucity of fat (Fig. 1*D*).

The blood supply to the sac is derived principally from vessels in the extraperitoneal fatty layer. These vessels accompany the sac through the opening in the crural canal. The femoral hernia sac usually has a narrow neck and a globular fundus. Once the sac has developed in its herniated position, replacement into the abdomen is the exception and not the rule. The contents of the sac (bowel, omentum or pelvic viscera) may be replaceable, but the sac itself usually remains more or less fixed in its newly developed position in the subcutaneous fat of the groin. The sac consistently leaves

the femoral canal lateral to the spine of the pubis and medial to the femoral vein, and this is one of the diagnostic features of femoral hernia.

The sac of femoral hernia differs considerably from that of inguinal hernia. The sac of the indirect inguinal hernia is usually made up of a thin layer of peritoneum and occupies a position within the cord structure surrounded by the internal spermatic fascia. When the hernial contents are reduced it may be impossible to palpate the sac, because of the thinness of the wall and its seclusion within the cord structures. The direct inguinal hernia sac has an outer thin-walled fascial layer derived from the defective transversalis fascia in the triangle of Hesselbach, an inner layer of peritoneum and an intermediate layer of extraperitoneal fat. This sac commonly has a broad base. On reclining, the sac and its contents may be returned into the abdomen with comparative ease.

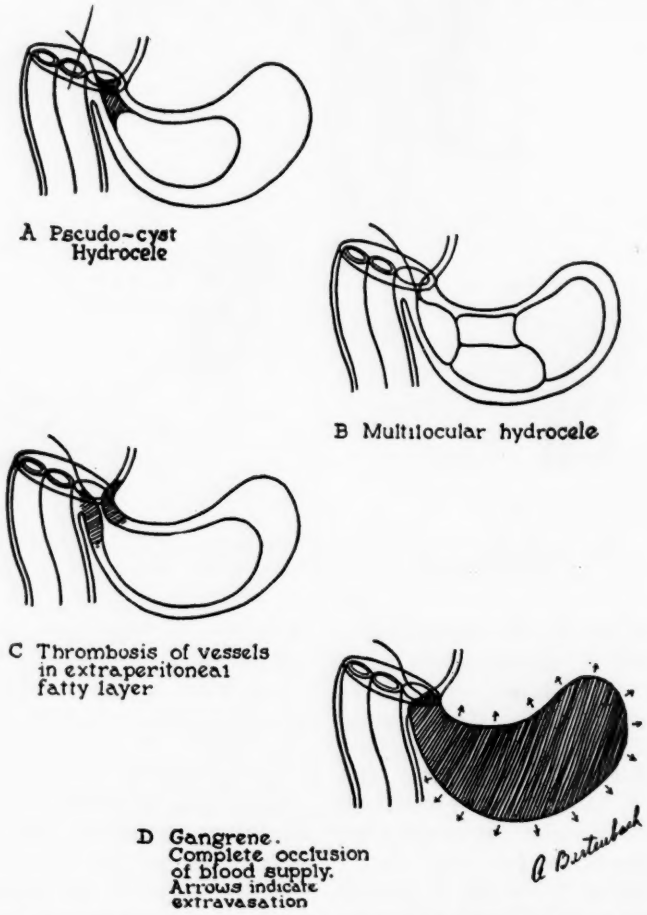
A Pseudo-cyst Hydrocele
B Multilocular hydrocele
C Thrombosis of vessels in extraperitoneal fatty layer
D Gangrene. Complete occlusion of blood supply. Arrows indicate extravasation
A Bertenbach

Fig. 2.—Changes in sac of femoral hernia caused by trauma (*A* and *B*) and interference with blood supply by thrombosis (*C*), which may cause gangrene (*D*) or necrosis (see text).

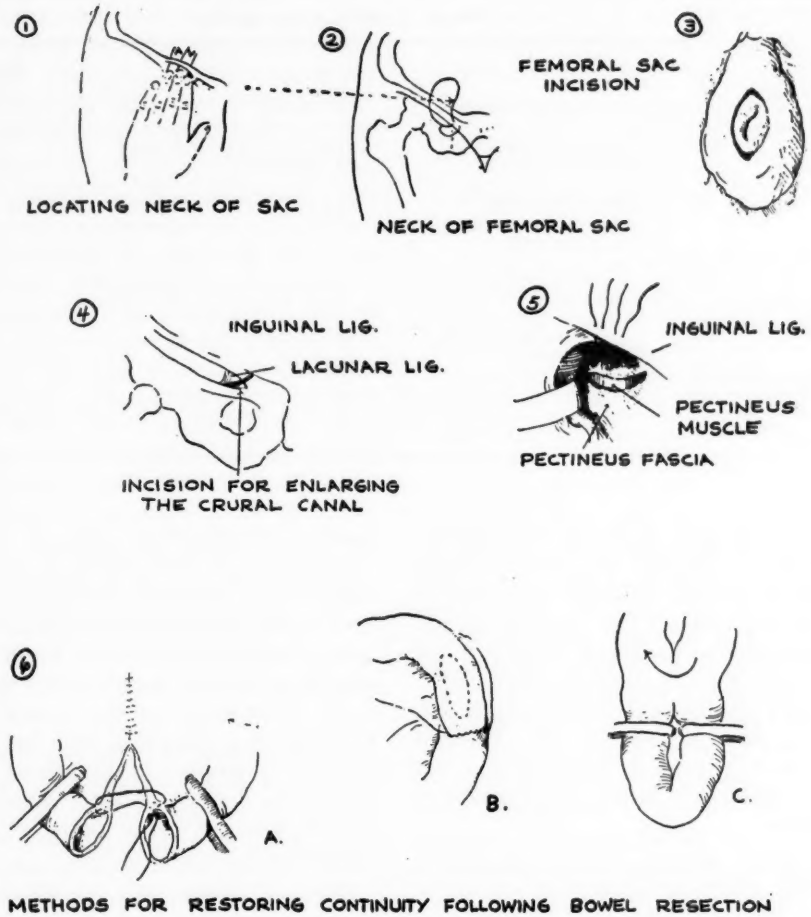

Fig. 3.—Technic of surgical repair of femoral hernia.

Trauma to the femoral hernia sac, either as a single injury or as repeated injury over a long period, may produce inflammatory changes in the sac. These may result in the formation of adhesions, with obliteration of the lumen. This is most apt to occur at the neck of the sac when the lumen is small. The accumulation of fluid in the sac occluded at the neck may cause it to resemble a cyst or an acquired hydrocele (Fig. 2, *A* and *B*). Multiple adhesions within the sac may result in loculi filled with fluid—a multiloculated hydrocele.

Changes in the intermediate layer of the sac derived from the extraperitoneal fat may interfere with the blood supply to the entire sac (Fig. 2*C*). Thrombosis with edema or exudation may so deprive the sac of its blood supply that any degree of change or even frank gangrene and necrosis of the sac may occur (Fig. 2*D*).

The repair of an inguinal hernia will not prevent the development of a femoral

TABLE 3.—*Patients Treated Nonsurgically*

Case	*Sex of Patient*	*Age of Patient*	*Diagnosis on Admission*	*Disposition*	*Length of Hospital Stay*	*Duration of Obstruction According to History*
1	F	32	Femoral hernia with pain in RLQ	Recovery and discharge	2 days	
2	F	78	Acute intestinal obstruction, cause undetermined	Death[1]	20 hours after admission	6 days
3	F	69	Cerebrovascular accident	Death[2]	19 days after admission	5 days
4	F	63	Incarcerated femoral hernia; tender	Taxis and recovery	2 hours	3 days

1. Postmortem examination showed strangulated bowel in a femoral hernia sac.
2. Postmortem examination showed strangulated bowel in a femoral hernia sac. Complication in concurrent disease.

hernia (Table 2*B*). In the 2 instances recorded here, fourteen and twenty years respectively elapsed between repair of the inguinal and that of the femoral hernia. It is doubtful that the repair of an inguinal hernia anatomically disturbs the femoral region sufficiently to predispose to formation of a femoral hernia. The lapse of many years would indicate that other factors play a role in the development of the hernia.

The other factors are illustrated in Table 2*C*. In this group both inguinal and femoral hernias were present. The increased intra-abdominal pressure, occasioned by coughing in 1 instance and straining in the other, played a role in the increase in size of the hernial protrusions. The higher incidence of hernias in elderly adults is probably associated with the increase in intra-abdominal pressure due to coughing, straining (constipation, difficulty in urination and laborious physical effort) and obesity, acting on tissues that have undergone wear and tear over many years. The actual growth of fat in the intermediate layer of the sac also helps to increase the size of the protruding mass.

Since a hernia presents the risk of a serious complication, such as intestinal obstruction or strangulation, it is advisable that a femoral hernia be repaired soon after its presence is detected. The hernial sac is superficial. Local anesthesia, if preferred, may be employed, with little disturbance to the patient. Early ambulation is desirable, and the disability usually is the least of any associated with abdominal hernia repair. Recurrence of a femoral hernia properly repaired is exceedingly rare (Fig. 3).

Table 3 summarizes the cases of 4 patients who did not choose surgical therapy. One of these (Case 1) left the hospital in two days after reduction of the incarcerated content of the sac. One patient died from acute intestinal obstruction of six days' duration but less than one day after admission to the hospital (Case 2). The patient was treated medically, and the hernia remained unrecognized. At autopsy the strangulated femoral hernia was demonstrated. Another patient died from a combination of causes, including bowel obstruction (Case 3). This patient was an obese 69-year-old white woman with a past history of two cerebrovascular accidents. On admission

she was semiconscious, and, although she did not respond to questions, she cooperated when requested. Additional abnormalities included left-sided broncho pneumonia, auricular fibrillation and old right hemiplegia with recent left hemiplegia.

The patient showed some improvement for the first ten days after hospitalization, and with a liquid diet there was no nausea or vomiting. Although incontinence of both urine and feces was noted on admission, there had been no bowel movements for five days prior to death. Postmortem examination showed strangulated bowel in a femoral hernial sac. It is not likely that any benefit would have been derived from repair of the femoral hernia in this case. The observation indicates, however, that the diagnosis was incomplete and suggests that repeated examinations, including the femoral region, should be made in the case of any patient with bowel obstruction or in one whose bowel movements have ceased for any length of time.

A fourth patient was relieved of pain and refused operation. The 2 patients who died were elderly; this fact, associated with the presence of an undiagnosed strangulated femoral hernia in both cases, illustrates the significance of the earlier comment. It is necessary to keep in mind this likely cause of sudden constipation or bowel obstruction in the elderly patient who cannot or does not indicate the site of the incarcerated bowel.

That death in such circumstances may occur without a full appreciation of the significance of the femoral hernia is attested also by the reports of Dunphy,[4] Gatch,[5] and others.[6]

Table 4 presents the significant data concerning the 124 femoral hernias operated upon. In 84 uncomplicated cases uneventful recovery took place after the operation. In 2 of them additional diagnoses were made after examination of the specimens removed at operation. In 1 a tiny nodule was found. Microscopic examination disclosed this to be metastatic carcinoma from the ovary. The hernia, which had been nonsymptomatic for several years, had only recently become enlarged and painful. The sac contained easily replaced contents, which were reduced before surgical intervention was begun. The tissue removed also contained a lymph node typical of chronic lymphatic leukemia, but the presence of this disease was known prior to the operation. In the second instance a lymph node was removed with a hernial sac containing fluid.[7] The microscopic picture showed lymphosarcoma, from which condition the patient subsequently died. In 29 instances of incarcerated or strangulated femoral hernia,

TABLE 4.—*Femoral Hernias Treated Surgically*
(124 Hernias in 121 Patients)

Type of Femoral Hernia	*Number*	*Deaths*	*Comment*
Uncomplicated	84	0	See footnotes 1 and 2
Incarcerated or strangulated with no resection	29	0	See footnote 3
Strangulated bowel with resection	11	1	See Table 5
	124	1	

1. In 1 hernial sac there was a nodule showing metastatic papillary adenocarcinoma. In addition, a lymph node showed chronic lymphatic leukemia.
2. In addition to the hernial sac, the specimen showed an enlarged lymph node, which on microscopic examination disclosed lymphosarcoma.
3. In addition to the hernial sac, the specimen showed reticulum cell type lymphosarcoma.

TABLE 5.—*Patients Treated by Intestinal Operation*

Case	*Age of Patient*	*Sex of Patient*	*Duration*	*Time of Admission*	*Time of Operation*	*Complication*	*Discharge*
1	65	F	48 hr.	5/8/46 5:30 p.m.	5/8/46 9:30 p.m.		5/28/46
2	59	F	48 hr.	7/18/47 5:00 p.m.	7/22/47 3:00 p.m.	Temperature 101 F., 6 days; pelvic abscess drained	9/1/47
3	50	F	7 hr.	10/11/47 2:45 p.m.	10/12/47 4:30 p.m.	Temperature 101 F., 2 days	10/22/47
4	44	F	24 hr.	11/14/49 7:00 p.m.	11/15/49 6:30 p.m.		11/26/49
5	54	F	10 hr.	12/31/49 1:15 a.m.	12/31/49 3:00 a.m.		1/10/50
6	65	F	14 hr.	5/9/50 9:50 a.m.	5/9/50 11:05 a.m.		5/18/50
7	79	F	5 days	5/4/52 4:15 p.m.	5/4/52 10:30 p.m.		6/1/52
8	79	F	3 days	9/7/56 10:00 p.m.	9/24/56 11:25 a.m.		10/3/56
9	86	F	24 hr.	1/9/57 3:15 p.m.	1/9/57 5:10 p.m.		1/30/57
10	85	F	3 days	9/11/57 3:15 p.m.	9/14/57 12:30 p.m.	Uremia	9/23/57 (died)
11	72	M	10 hr.	11/8/57 8:20 p.m.	11/9/57 9:35 a.m.		11/17/57

surgical intervention relieved the condition. In 1 of these, sections from a removed lymph node also showed lymphosarcoma.

Table 5 is a summary of the 11 cases of strangulated bowel in all of which the patients required bowel resections and 1 of them died. An analysis of these cases, however, illustrated several points of clinical significance. Even in this small series delay in necessary treatment occurred in 3 instances, in which the full significance of a femoral mass was not appreciated by the house staff on admission of the patient to the hospital. Although resection of the bowel was readily accomplished in each instance, some disability might have been averted by earlier operation, especially in Case 2. Recovery and healing eventually occurred even in this case. Early diagnosis and early treatment, however, will leave less to chance and prevent the hazards entailed by delay.

Delay in treatment is often due to error in diagnosis. This is frequently the result of failure to examine for a mass in the femoral region in the presence of preobstructive gastrointestinal symptoms, or failure to appreciate the significance of a femoral mass when it is noted.

One of the most common causes of intestinal obstruction is incarceration of abdominal contents in a hernial sac. Examination, therefore, of the sites of the hernial rings is necessary in order to make a diagnosis. Local pain may be so mild that it does not direct attention to the seat of

the trouble. The mass is commonly small, and for this reason, in some instances, the patient or the surgeon may fail to appreciate the relation between the abdominal symptoms and the unobtrusive mass in the groin.

SUMMARY

In this series there were 125 patients with a total of 128 femoral hernias. One hundred and twenty-one of these patients were operated on for 124 hernias (3 bilateral). Eleven required resection of strangulated bowel. There was 1 death in this group.

The following clinical features of this condition are emphasized:

1. Femoral hernias are frequently mistaken for the inguinal variety and remain uncured after the inguinal operation.

2. Femoral hernias frequently are overlooked as a cause of intestinal obstruction. This error in diagnosis is responsible for delay in specific treatment for this condition.

3. Resection of the bowel after strangulation, when undertaken early, is easily accomplished, with little disability for the patient.

4. Neglect of the condition favors complications that add to the disability and at times results in the death of the patient.

5. The possibility of malignant change associated with femoral hernia must be appreciated.

SUMARIO

Apresenta-se uma série de 125 pacientes com um total de 128 hérnias femorais. Cento e vinte e um dêstes pacientes foram operados para um total de 124 hérnias, pois três pacientes apresentavam defeito bilateral. Em onze casos ressecção de segmento de intestino estrangulado foi necessária. Houve uma morte nêste grupo.

No quadro clínico desta condição o seguinte é digno de atenção; 1. Frequentemente hérnias femorais são diagnosticadas como sendo da variedade inguinal e permanecem incuradas após a operação inguinal.

2. Freqûentemente as hérnias femorais não são consideradas como causa de obstrução intestinal e êste erro diagnostico é responsável pela demora na instituição no tratamento específico para esta condição.

3. Ressecção de segmento intestinal estrangulado quando efetuada cedo não apresenta muitas dificuldades técnicas e causa pouca incapacidade para o paciente.

4. Negligência para com a condição favorece complicações que aumentam a incapacidade e às vêzes resultam em morte do paciente.

5. A possibilidade de degeneração maligna associada com hérnia femoral deve ser apreciada.

RESUMEN

Se refiere este trabajo a un conjunto de 125 enfermos con un total de 128 hernias femorales. En 121 de tales enfermos se operaron 124 hernias (3 bilaterales). 13 casos sequirieron resección de un asa extrangulada. Uno de los enfermos operados falleció.

Se subrrayan los siguientes puntos clínicos:

1. Las hernias crurales se confunden facilmente con las inguinales y quedan incuradas después de la operación inguinal.

2. Muchas veces se olvida tener presente la hernia crural como causa de obstrucción intestinal. Tal error diagnóstico es responsable del retraso en el tratamiento especiífico de la obstrucción.

3. La resección del asa extrangulada

cuando se hace pronto es cosa fácil, con pocas molestias para el enfermo.

4. El retraso en el conocimiento de la afección favorece las complicaciones y puede ser causa de la muerte del enfermo.

5. Se debe tener en cuenta la transformación maligna asociada con la hernia crural.

RIASSUNTO

La serie presentata comprende 125 malati con un totale di 128 ernie femorali; furono operati 121 di essi per 124 ernie (3 bilaterali). In 11 fu necessaria la resezione di anse del tenue per strangolamento, e fra questi vi fu un decesso.

Gli aspetti più interessanti furono i seguenti:

1. Molte delle ernie femorali vengono scambiate per inguinali e naturalmente non guariscono dopo plastica inguinale.

2. Spesso non vengono riconosciute come causa di occlusione intestinale, e ciò ritarda la diagnosi e la terapia corretta di questa condizione.

3. La resezione intestinale dopo strozzamento può essere eseguita agevolmente, se riconosciuta, e senza pregiudizio per il risultato definitivo.

4. Il mancato riconoscimento di anse intestinali strozzate può condurre a morte il paziente.

5. Si deve tener presente anche la possibilità di associazione con il cancro.

ZUSAMMENFASSUNG

Der Verfasser berichtet über eine Serie von 125 Kranken mit insgesamt 128 Schenkelbrüchen. An 121 von diesen Patienten wurden 124 Bruchoperationen (drei doppelseitige) vorgenommen. In elf Fällen war die Resektion eines abgeklemmten Darmabschnittes notwendig. In dieser Krankenserie kam ein Todesfall vor.

Die folgenden klinischen Merkmale der Erkrankung werden hervorgehoben:

1. Femoralhernien werden oft mit Leistenbrüchen verwechselt und bleiben nach dem inguinalen Eingriff ungeheilt.

2. Als Ursache einer Darmobstruction werden Schenkelbrüche häufig nicht erkannt. Ein derartiger diagnostischer Versager ist für die Verzögerung der spezifischen Behandlung der Erkrankung verantwortlich.

3. Die Resektion eines eingeklemmten Darmsegments lässt sich, wenn sie frühzeitig unternommen wird, leicht ausführen, ohne dem Kranken eine wesentliche körperliche Behinderung zu verursachen.

4. Eine Vernachlässigung der Krankheit begünstigt das Auftreten von Komplikationen, die zu einer zusätzlichen körperlichen Untauglichkeit und gelegentlich zum Tode des Patienten führen.

5. Die Möglichkeit bösartiger Veränderungen in Verbindung mit einem Schenkelbruch muss beachtet werden.

RÉSUMÉ

Statistique de 128 opérations de hernies fémorales, bilatérales dans 3 cas; résection d'un étranglement intestinal dans 11 cas avec un décès.

Remarques:

1. Les hernies fémorales sont souvent confondues avec les hernies inguinales, d'où erreur d'indication opératoire.

2. L'on oublie fréquemment que la hernie fémorale est une cause d'obstruction intestinale. L'erreur de diagnostic qui en résulte est responsable du retard du traitement spécifique de cet état.

3. La résection intestinale précoce après étranglement est simple et ne présente que peu d'inconvénients pour le malade.

4. La méconnaissance de cet état peut

avoir des conséquences graves et provoquer une issue fatale.

5. Il faut tenir compte de la possibilité d'une dégénérescence maligne associée à la hernie fémorale.

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. . . The brain is the interpreter of comprehension. Accident and convention have falsely ascribed that function to the diaphragm which does not and could not possess it. I know of no way in which the diaphragm can think and be conscious, except that a sudden access of pleasure or of pain might make it jump and throb because it is so thin and is under greater tension than any other part of the body. Moreover, it has no cavity into which it might receive anything good or bad that comes upon it, but the weakness of its construction makes it liable to disturbance by either of these forces. It is no quicker in perception than any other part of the body, and its name and associations are quite unwarranted, just as parts of the heart are called auricles though they make no contribution to hearing. Some say too that we think with out hearts and it is the heart which suffers pain and feels anxiety. There is no truth in this although it is convulsed as is the diaphragm and even more for the following reasons: blood-vessels from all parts of the body run to the heart and these connections ensure that it can feel if any pain or strain occurs in the body. Moreover, the body cannot help giving a shudder and a contraction when subjected to pain and the same effect is produced by an excess of joy, which heart and diaphragm feel most intensely. Neither of these organs takes any part in mental operations which are completely undertaken by the brain.

—*Hippocrates*

Noninflammable Cyclopropane-Helium and Oxygen Mixtures for Use in the Reserve Midget Anesthesia Machine

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THE science of anesthesiology has made more progress during the past decade than in all of the previous century. The great preponderance of that progress has been largely confined to the United States, the British Commonwealth, Western Europe and a few of the metropolitan areas in South America. More than half of the countries of the world do not have facilities for manufacture, transportation and utilization of the compressed anesthetic gases and oxygen. The control of human pain during surgical and obstetric procedures in most of the world is primitive indeed, especially in the sparsely populated areas. Chloroform, open drop ether, local anesthetics and, with increasing frequency intravenous anesthetics are too often employed under conditions that do not provide the patient with necessary safeguards.

Most anesthetic gas machines with list prices varying from $800 to $1500 without the frequently used accessories are too costly for consideration by most of the world's hospitals and clinics. The tremendous weights (200 to 400 pounds) and the multitude of precision gauges, reducing valves, and flowmeters, so necessary on all standard anesthetic gas machines, do not permit global transportation of either the machines or the filled (and returned empty) cylinders of compressed gas. The jolts and jars of sea and rail transportation and the lack of facilities on the local scene for recheck of the accuracy of the flowmeters oppose additional impediments to the spread of modern anesthetic technics. Consequently the developing skills of surgery and obstetrics are limited to a few regional centers, with the majority of the population still beyond the reach of modern medicine.

One of us (Hingson[1]) made a study of local conditions in twenty-two countries and concluded that one of the great needs in world medicine today is the development of economical equipment and carefully measured portable, miniature disposable cylinders of oxygen and gas anesthetics.

Consequently, for the past four years our staff in the Western Reserve University, the Z & W Manufacturing Corporation and the Continental Hospital Industries have combined forces to produce 6,000 of these machines, which can be

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held in the palm of one hand and will release 6,500 cc. of oxygen for resuscitation at the turn of the wrist; or which will provide a premixed combination of noninflammable cyclopropane, helium and oxygen for instantaneous anesthesia in children and adults, without the possibility of overdosage in a single pair of cylinders. The anesthesia thus obtained within one minute is sufficient to provide six to twelve minutes of operating time in surgery, dentistry or obstetrics.

Up to the time of writing, more than 10,000 such anesthetics have been administered, and thousands of cylinders of oxygen and helium have been used in individual resuscitations, with the machine as an escape inhalator in civil defense, and in industries in which there is danger of exposure to noxious gases.

This paper will deal primarily with the development and application of the noninflammable anesthetic mixtures during surgical and obstetric procedures.

The use of cyclopropane (C_3H_6), ethylene (C_2H_4), diethyl ether (C_2H_520), divinyl ether (C_2H_120), ethyl chloride (C_2H_5Cl), and most of the recently developed ethers for anesthesia has resulted in potentially explosive mixtures that have been associated too frequently with electrostatic ignition leading to death of the patient and other disasters.

During the past two years, in the University Hospitals of Cleveland, the Department of Chemistry of Western Reserve University and the Department of Physics of Case Institute of Technology, and in the laboratories of The Z & W Manufacturing Corporation, Inc., we have developed nonexplosive mixtures of cyclopropane, oxygen, and helium or nitrogen. These mixtures have been tested in more than 3,000 short anesthesias to determine the safest and most effective mixtures that would preserve for the patient the highest concentrations of oxygen, the most rapid induction and the minimum of undesired side effects. To assist us in our assay of anesthetic efficiency and patient safety, we have carried out before anesthesia, and during its induction and maintenance, simultaneous electrocardiographic determinations, electroencephalographic determinations, blood pressure, pulse and cardiac output studies, blood level concentrations of cyclopropane, oxygen and carbon dioxide studies, and correlation of depth of clinical anesthesia in both children and adults, for surgical, obstetric and dental procedures.

In order that the implications of laboratory tested nonexplosive mixtures with cyclopropane introduced by this study might be better understood, we quote the summary of the problem of explosions related to anesthesia presented by Curtiss B. Hickcox in his chapter in Hale's *Anesthesiology by 40 American Authors.*[2]

"*Investigational Ward.* — There was little interest in the problem of anesthetic fires and explosions until ethylene was accepted as a common anesthetic agent. About 1925 reports began to appear in the medical literature of explosions with this agent, many of which were fatal to patients. Safeguards were suggested but little progress was made in the prevention of such accidents. After the introduction of cyclopropane in clinical anesthesia (1933) additional explosions were reported and some hospitals banned the use of both agents. Investigators in the medical sciences, as well as in the engineering specialties, became interested in the problem primarily from the standpoint of safety to patients, hospital personnel and property, and secondarily in an effort to find methods which would allow anesthesiologists to use the flammable agents which offered ideal operating conditions.

"In 1940 the first of a series of publications on the explosive properties of anesthetic agents appeared as a result of the

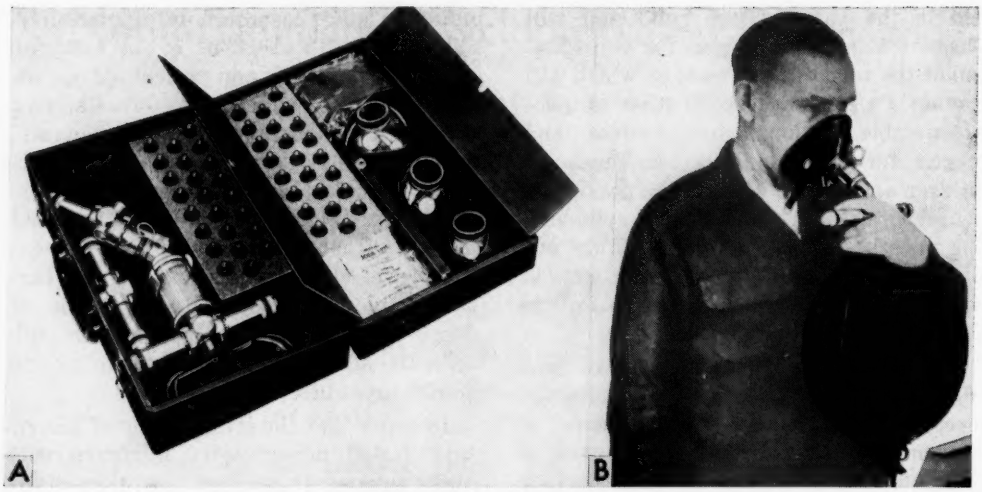

Fig. 1.—*A*, two Western Reserve anesthesia machines with extra oxygen side arm, complete with 50 cylinders of cyclopropane-helium, oxygen-helium and oxygen, sufficient for twenty-four short anesthesias or twelve resuscitations. This case also is equipped with masks of assorted sizes and individual packages of soda lime. *B*, machine in position as escape inhalator.

cooperative efforts between the United States Bureau of Mines of the Department of the Interior, and a committee under the direction of the Department of Industrial Hygiene, School of Medicine, University of Pittsburgh. Several hospitals and industries in the Pittsburgh area were represented on this committee. The first report of investigations* dealt with the prevention of explosions by diluting cyclopropane and air or cyclopropane and oxygen mixtures with nonanesthetic gases such as nitrogen, helium, or carbon dioxide. Since cyclopropane is ordinarily used with oxygen in clinical anesthesia, the tests were directed toward the development of a procedure whereby the explosive hazards might be reduced or entirely eliminated by reducing and controlling the oxygen concentration. The oxygen content of explosive mixtures may be reduced by the addition of such gases as carbon dioxide, nitrogen, or helium.

"Carbon dioxide was not practical in diluting cyclopropane - oxygen mixtures since the high concentrations of carbon dioxide necessary to eliminate explosive hazards had markedly undesirable physiological effects on patients who inhaled such mixtures.

"Nitrogen and helium both have value in the production of nonflammable anesthetic mixtures when added to cyclopropane and oxygen. Helium is a light gas (about one-seventh as heavy as nitrogen) which due to its low density can be respired with less effort than nitrogen. The flame quenching characteristics on inert gases depend upon two factors: (1) the molecular heat capacity of the gas, and (2) its thermal conductivity. In addition, gaseous mixtures containing helium are more difficult to ignite by electric discharges than mixtures containing similar percentages of other inert gases. Because of this characteristic, it should be more difficult to ignite explosive mixtures containing high percentages of helium inside

*Jones, G. W.; Kennedy, R. E., and Thomas, G. J.: Explosive Properties of Cyclopropane: Prevention of Explosions by Dilution with Inert Gases, Bureau of Mines Report on Investigations No. 3511 (May) 1940.

or outside of anesthetic machines by static sparks.

"On a theoretical basis the following nonflammable mixtures appear to offer the most promise for anesthetic use:

TABLE 2.—*Composition, Per Cent by Volume*

Mixture Number	*Cyclopropane*	*Oxygen*	*Helium*
1.	15	20	65
2.	20	20	60
3.	25	25	50
4.	30	30	40

"If it is desired to control the atmosphere in the anesthetic machine so that the composition at all times is outside the explosive area, the explosive hazards can be determined from Figure 1 (Page 712), provided the composition of the mixture is known. If a mixture represented by No. 3 in Table 2 is decided upon the following method of administration may be followed: In a closed, recirculating, anesthetic machine the free space in the machine and the patient's lungs when administration is begun, will consist largely of normal air containing approximately 20.9 per cent oxygen and no cyclopropane. This condition is represented by point H (Figure 1). As the 25-, 25-, 50- per cent cyclopropane-oxygen-helium mixture is administered the composition of the mixture in the apparatus and the patient's lungs will shift along the broken line from H to J and pass through a narrow range of explosive mixtures as shown. However, this phase can be carried out under conditions that are non-explosive if the oxygen content is lowered to 10 per cent by increasing the supply of helium so that the composition of mixtures passes from H to E and then to J. The patient may experience discomfort during this short period because of the low concentration of oxygen.

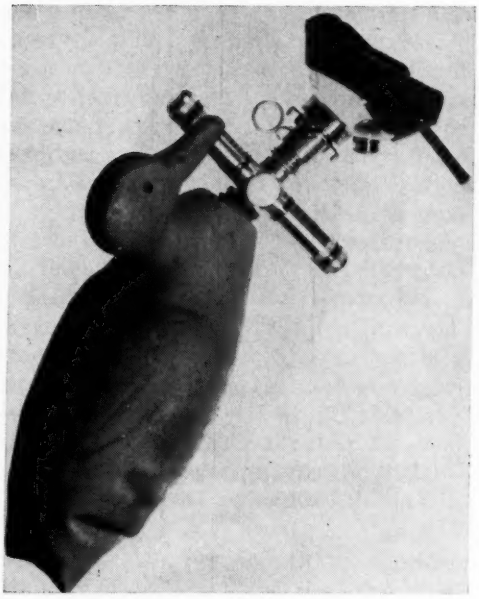

Fig. 3.—Anesthesia machine adapted for pediatrics, with a 4-liter rebreathing bag molded in the form of Donald Duck.

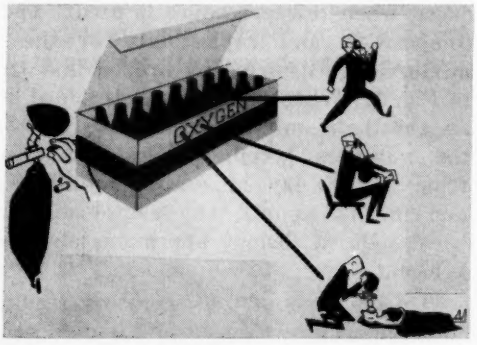

Fig. 2.—Measured performance in resuscitation as an oxygen inhalator in heart disease or in high altitudes, and an escape inhalator through noxious gas, of a carton of 24 cylinders of oxygen. Carton containing 24 cylinders of oxygen and weighing only 24 ounces contains sufficient oxygen for the needs of a man walking 3 miles at 3 miles per hour; for a man in a sitting position, two hours, and for artificial respiration, one hour, with allowance for 75 per cent leakage. Cylinders provide 3,000 cc. each, a total of 72,000 cc., or 18 gallons, of packaged oxygen. This represents a more than 50 per cent reduction in the weight of packaged oxygen as currently available in reservoir cylinders.

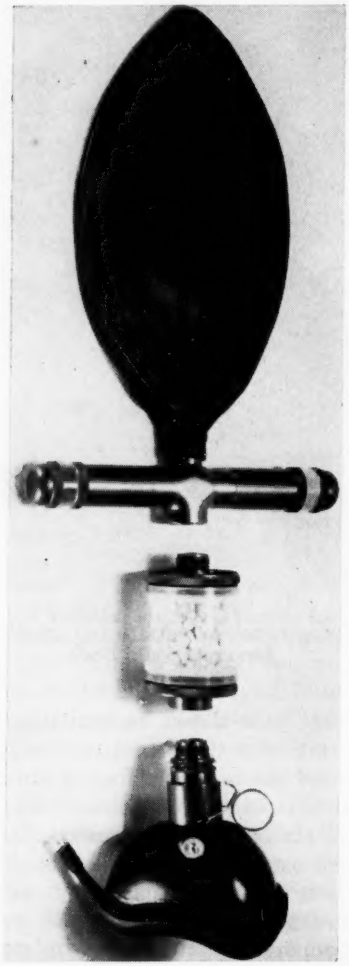

Fig. 4.—Subassembly of the Western Reserve machine, with soda lime canister.

"The mixture represented by J can then be administered to the patient through the anesthesia without danger of explosions inside the machine (additional oxygen must be administered to replace that consumed by the basal requirements). Should the machine leak, fires may occur at the point of leakage if the gas mixture is ignited, because the addition of air to the mixture represented by J (Fig. 1) will shift the composition of the mixture to the left along line JH and the mixture will become explosive in the area shown. At the end of the period of anesthesia, the mask may be removed and the patient allowed to breathe normal air until the anesthetic mixture is removed from the lungs. During this time the composition of the mixture in the patient's lungs will shift along the broken line from J to H and pass through the small explosible area indicated.

"Although the mask, apparatus, and the patient's lungs will contain explosive atmospheres for a very short period both at the beginning and end of the administration of the anesthetic, this method eliminates the violently explosive mixtures that usually are present throughout the administration of anesthesia.

"The danger of explosion in sweeping out the patient's lungs with pure oxygen at the end of an operation to effect quick recovery becomes apparent on inspection of the composition of the mixtures produced when this procedure is used. The composition and explosibility of these mixtures are depicted by broken line JA in Fig. 1. When pure oxygen is added to an anesthetic mixture represented by J, the mixtures become explosive almost from the time oxygen is first administered and continue so until the cyclopropane has been reduced below approximately 2.4 per cent.

"On the basis of the laboratory results in rendering cyclopropane-oxygen mixtures nonexplosive by the addition of helium, a technic was suggested for the clinical administration of a three gas mixture to patients. Clinical tests were performed for a variety of operative procedures on patients between the ages of twelve and seventy-eight years for varying periods up to two and one-half hours. Samples of the anesthetic atmospheres were tested for flammability and explosi-

bility periodically during the operation and part of each sample was retained for later tests in the laboratory. Seven hundred clinical experiments were conducted. In some cases the mixtures were explosive during certain periods of the operation. In other cases, the oxygen was purposely increased to determine how far the concentration of oxygen could be raised and still remain outside the explosive range. It was found that for best results the oxygen content should range from 15 to 22 per cent and cyclopropane should be kept between 10 and 20 percent to maintain the mixtures outside the explosive range and also be satisfactory from the standpoint of anesthesia. The helium content of the atmospheres should range from about 62 to 70 per cent. In the laboratory, it had been shown that patients could breathe the helium and oxygen mixtures containing oxygen as low as 10 percent for periods of one-half hour without marked discomfort. However, when patients were anesthetized with cyclopropane, helium and oxygen mixtures in which the oxygen content ranged from about 9 to 14 per cent there was definite cyanosis in all patients and an increase in pulse rate. It was also observed that when the carbon dioxide absorber was not in the anesthetic circuit the patients did not tolerate lowered oxygen concentrations as well as when the absorber was in the circuit. When usual anesthetic technics for the administration of cyclopropane were used all of the mixtures tested were highly explosive throughout the operation. It was concluded from the clinical tests that a concentration of oxygen greater than 30 per cent in cyclopropane-helium-oxygen mixtures is rarely necessary and that maintenance of oxygen below the 30 per cent level will go a long way toward reducing the number and violence of explosions, even if nonflammability of the mixtures is not attained in all instances."

In May 1954, we began to consider means of developing a packaged nonexplosive mixture for anesthesia for use in the Reserve Midget portable anesthesia machine.[3] One of us (Brown) reviewed all of the noninflammable mixtures of anesthetic gases developed and possible additives for cyclopropane-oxygen mixtures. In June 1954, another of us (Gregg) con-

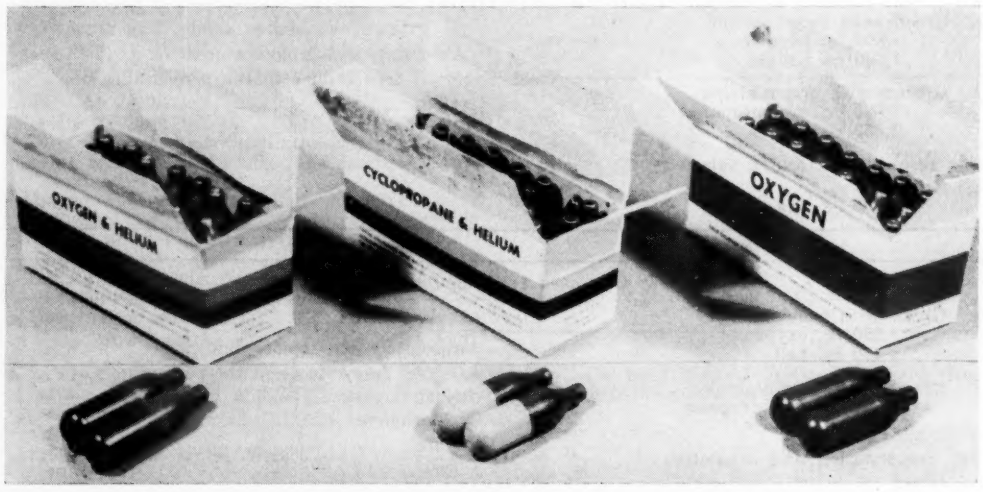

Fig. 5.—Available cartons of color-designated thumb-sized steel cylinders of compressed gases.

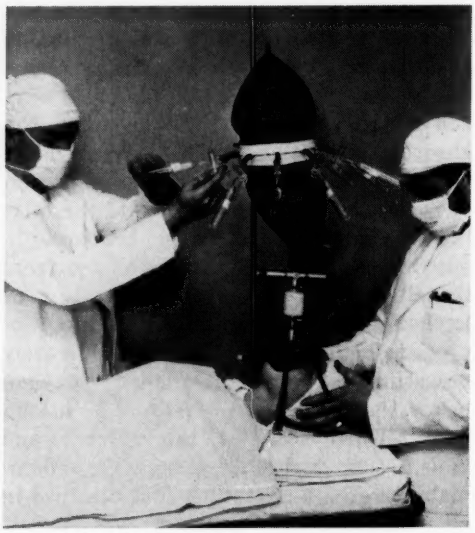

Fig. 6.—Research vacuum sampling machine to determine minute-by-minute changes of mixed noninflammable gas percentages.

sidered the relative explosive hazards associated with the Reserve Midget machine in comparison with presently used equipment. He stated that, even without diluents, "The hand unit possesses not more than about 1/3 the destructive potential of the standard machine from a primary explosion viewpoint. This ratio becomes very much smaller if one considers an explosion of a standard machine with a leak such that most of its bottled cyclopropane escaped to the atmosphere and there formed an explosive mixture. For a secondary explosion of this kind, assuming a bottle of 378 liters capacity and a room with no ventilation, one would obtain a minimum lower figure of 1/240.

"One could go still further and estimate the tertiary effects of knocking over larger bottles of gas in the room and igniting these; however, the major danger here would be from fire rather than explosion since there would be a slow formation of an explosive mixture.

"Under any circumstance, the hand unit appears very much safer than a standard gas machine."

In consultation with Dr. George J. Thomas and the Testing Laboratory of the United States Bureau of Mines, we began the packaging of anesthetic mixtures of compressed cyclopropane and

TABLE 3.—*Absolutely Nonexplosive Mixture*

1. Green with brown stripe 1,800 cc. oxygen 1,050 cc. helium	Absolutely non-explosive mixture Yields 6,000 cc. free volume in the percentages of:
2. Orange with brown stripe 1,800 cc. cyclopropane 1,350 cc. helium	Oxygen ..... 30% Cyclopropane ..... 30% Helium 40%
For resuscitation and inhalation	
3. Green 3,400 cc. oxygen	

TABLE 4.—*Gases Available for Clinical Use*

1. Green with brown stripe 1,650 cc. oxygen 470 cc. helium	Absolutely non-explosive mixture Yields 6,000 cc. free volume in the percentages of:
2. Orange with brown stripe 2,200 cc. cyclopropane 1,180 cc. helium	Oxygen ..... 30% Cyclopropane ..... 40% Helium 30%
For resuscitation and inhalation	
3. Green 3,400 cc. oxygen	

TABLE 5.—*Reserve Midget Portable Anesthesia Machine: Applications from March 1, 1954, to Sept. 30, 1955**

Cleveland: University City* Huron Road and St. Luke's Hospitals
Montreal: Queen Elizabeth Hospital
Chicago: University of Illinois Research Hospital†
New York: Kings County Hospital§

	Number of Patients	*Cardiac Irregularity or Bradycardia Below 60*	*Apnea Requiring Controlled Ventilation*	*Other Complications: (Laryngospasm; Emergency Delirium, Convulsions, etc.)*
Anesthesia				
Dentistry				
Adult dental extractions	155	3	3	6
Pediatric dental extractions	490	8	3	6
Obstetrics				
Precipitate delivery	150	4	3	2
Supplement for failed or inadequate conduction blocks	50			
Maternal or fetal emergencies, versions, extractions, etc.	80	2		1
Anesthesia required for uncooperative patients receiving spinal anesthesia	8			
Rapid induction for maintenance with another anesthetic	5			
Surgical Procedures				
Induction for tonsillectomy in children	1,150	8	4	8
Pediatric, orthopedic and general surgery	300	1		2
Adult short surgical operations	80	2		
Anesthesia for eye operations	110			
Induction of anesthesia for adult surgery	144		2	1
Anesthesia for intubation	80			
Removal of burn dressings, surgical packs and sutures	54			
Electroshock anesthesia	40			
Anesthesia for experiment testing depth and volume uptake, cyclopropane (medical students, residents and nurses)	78			
	2,974	28	15	26
Therapy				
Postanesthesia hyperventilation	120			
Acute cerebral hemorrhage and cerebral thrombosis	2			
Oxygen and/or helium in asthma and cardiac disease	93			
Oxygen at high altitudes—mountains and aircraft	76			
Testing with fireman's mask under simulated rescue conditions and mobile evacuation maneuvers	156			
Total uses	3,421			

*Since September 1955 an additional 3,000 anesthesias have been induced in the University Hospitals of Cleveland and 2,000 cases reported from consulting hospitals, with essentially the results recorded in this table.

†85 cases
†150 pediatric dental cases.
§175 cases

helium, as well as separate cylinders loaded with oxygen and helium, in the proportions listed in Table 3. Combinations of one cylinder of each type in the machine gives an anesthetic mixture that is nonexplosive.

We verified the nonexplosive character of our mixtures by placing them in an explosion chamber (Fig. 2) and tested for inflammable properties by means of electric spark and flame ignition. The absence of explosion in our tests with these mixtures confirmed the published data of the Bureau of Mines.[4]

When one looks at Figure 1, it is evident that safety is increased in the use of higher concentrations of cyclopropane, and our clinical studies revealed that induction of anesthesia was also effected more promptly and smoothly with mixtures of higher concentrations of cyclopropane. Through a series of clinical tests, we have selected the mixtures designated in Table 4 as the ones to be produced for most satisfactory clinical use.

In testing of explosibility of these mixtures, we have had the following experience (Fig. 3): More than 2,000 quantitative and qualitative gas measurements by the chemical method from 529 individual samplings before and during 75 random anesthetics have been completed with patients of varying size, weight and physical condition, for various surgical,

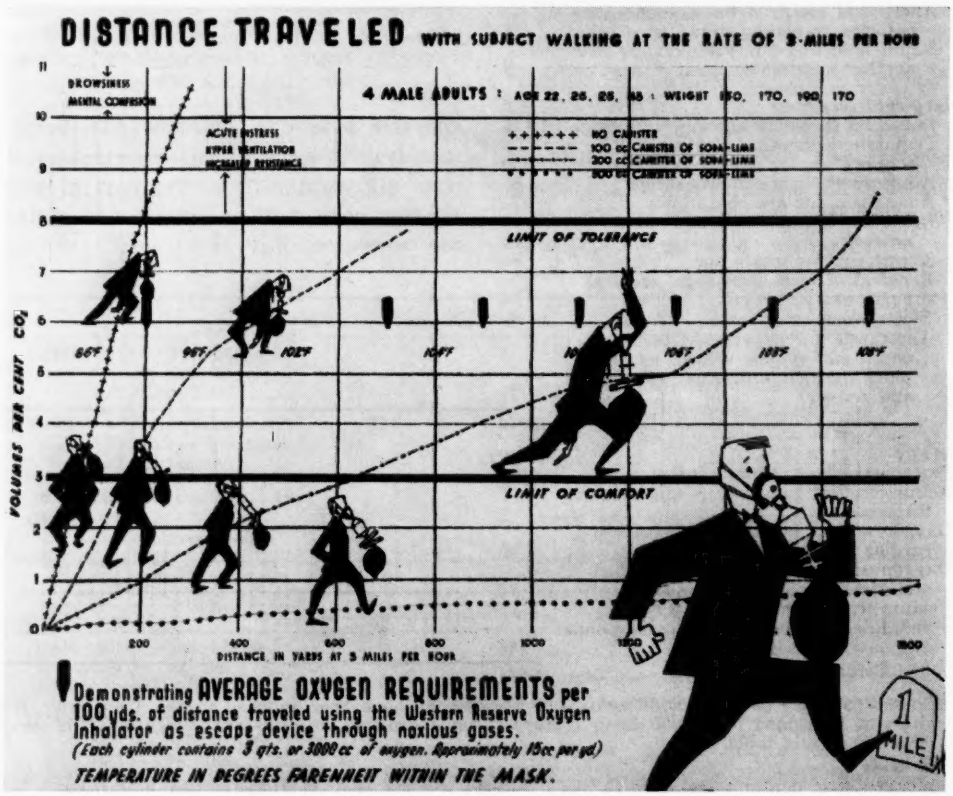
DISTANCE TRAVELED WITH SUBJECT WALKING AT THE RATE OF 3-MILES PER HOUR
4 MALE ADULTS : AGE 22, 26, 28, 45 : WEIGHT 150, 170, 190, 170
DROWSINESS
MENTAL CONFUSION
ACUTE DISTRESS
HYPER VENTILATION
INCREASED RESISTANCE
NO CANISTER
100 cc CANISTER OF SODA-LIME
200 cc CANISTER OF SODA-LIME
500 cc CANISTER OF SODA-LIME
LIMIT OF TOLERANCE
LIMIT OF COMFORT
VOLUMES PER CENT CO2
DISTANCE IN YARDS AT 3 MILES PER HOUR
Demonstrating AVERAGE OXYGEN REQUIREMENTS per 100 yds. of distance traveled using the Western Reserve Oxygen Inhalator as escape device through noxious gases.
(Each cylinder contains 3 qts. or 3000 cc of oxygen. Approximately 15cc per yd)
TEMPERATURE IN DEGREES FAHRENHEIT WITHIN THE MASK.
1 MILE

Fig. 7.—Carbon dioxide removal studies, showing effective life of soda lime in 100 cc., 200 cc. and 500 cc. to-and-fro canisters.

obstetrical and dental procedures. More than 96 per cent of these samplings remained outside both spark and flame ignition range. Three per cent of these samplings indicated that the anesthetic mixtures moved within the flame ignition range for a few breaths, either early in induction or after the eighty-eighth to the ninetieth breath. In a substantial number of these, pure oxygen was added to prove this predictable point. In 1 per cent of the cases there were momentary spark ignition range percentages; but only half of these moved into this range unpredictably, since pure oxygen was again added to prove the point. In those cases (danger group) in which moving into the spark ignition range occurred unpredictably, hindsight revealed that in more than one half of these it could have been prevented by weighing the cylinders to eliminate underfills of cyclopropane. At present the

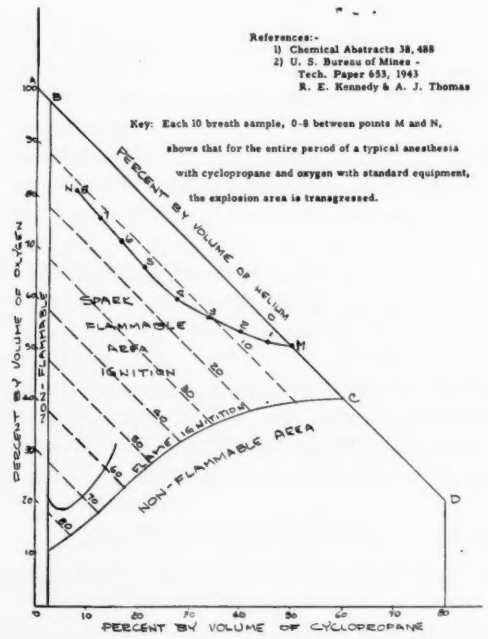
References:-
1) Chemical Abstracts 38, 488
2) U. S. Bureau of Mines -
Tech. Paper 653, 1943
R. E. Kennedy & A. J. Thomas
Key: Each 10 breath sample, 0-8 between points M and N,
shows that for the entire period of a typical anesthesia
with cyclopropane and oxygen with standard equipment,
the explosion area is transgressed.
PERCENT BY VOLUME OF HELIUM
SPARK
FLAMMABLE
AREA
IGNITION
FLAME IGNITION
NON-FLAMMABLE AREA
NON-FLAMMABLE
PERCENT BY VOLUME OF OXYGEN
PERCENT BY VOLUME OF CYCLOPROPANE

Chart 1.

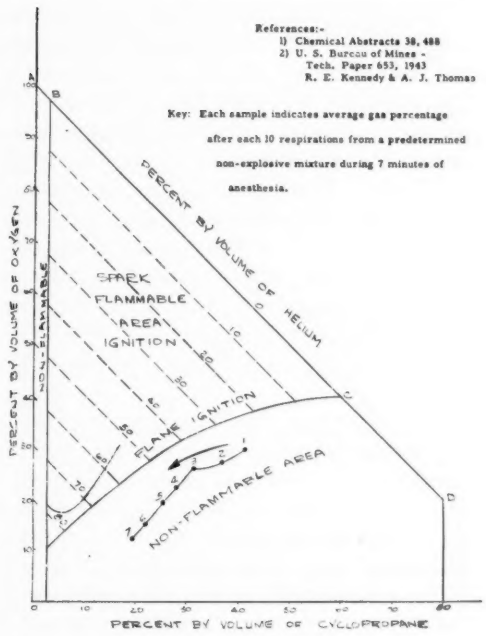

Chart 2.

approximately 1 per cent of unpredictable residue must be considered due to mechanical failure and pressure blockage of the pin perforating mechanism. Even this number is now reduced by a double-action unwinding of the side arm for a quarter turn to move thoroughly open the port that might be blocked by a wedge flap on the metal cap.

Samples K to L represent a typical adult patient who remained in the noninflammable range for seven minutes of anesthesia. Note that the oxygen concentration was approaching the low level of 16 per cent at the end of the first six minutes of the procedure (Chart 1). Compare the explosion curve in Chart 2, Case 10, which remained entirely in the explosive range for eight minutes, with the case of the adult patient whose explosion curve, in Chart 1, indicated in all samples from K to L a noninflammable range.

In order to achieve these percentages and Analysis of Cyclopropane Anesthesia was necessary to set up specifications for the upper and lower concentrations of oxygen, cyclopropane and helium mixtures. These are designated in Figure 5. The heavy lines between the upper and lower limits indicate the average percentage by volume of cyclopropane and oxygen, from 0 to 90 breaths for 73 patients, samples being taken from the rebreathing bag of the Reserve Midget portable anesthesia machine into 20 cc. vacuum tubes (Fig. 6).

The chemical method of testing these percentage mixtures was that described by three of us (Brown, Weiss and Hingson); these data under the title "The Sampling and Analysis of Cyclopropane Anesthesia Mixtures," are to be published. Cyclopropane was absorbed from the mixture in the Haldane-Boothby-Sandiford apparatus (modified by us) by means of sulfuric acid. Carbon dioxide was absorbed from the residue mixture in potassium pyrogallate.

After cyclopropane, water vapor, carbon dioxide and oxygen were absorbed from the exhaled samples in the rebreathing bag, the final residue could be considered to consist of nitrogen and helium (both inert diluents and nonexplosive buffers). The device is shown in Figure 7.

Clinical Results.—The use of the Reserve Midget machine for surgery and obstetrics was presented in the previously mentioned preliminary report, "New Portable Anesthetic Gas Machine and Resuscitator: Preliminary Report," published in the *Journal of the American Medical Association* on Oct. 9, 1954, and for dentistry in the July 1955 issue of *Dental Digest*, "A New Portable Resuscitator and Anesthetic Gas Machine."[3]

We have continued our clinical use of this machine in the University Hospitals of Cleveland, Queen Elizabeth Hospital, Montreal, University of Illinois Research Hospital, Chicago, and Kings County Hospital, Brooklyn, in more than 3,500 cases. The clinical results will not be analyzed in this paper. They are recorded, however, in Table 5. There were no serious complications at any time.

SUMMARY AND CONCLUSIONS

1. The use of nonexplosive anesthetic mixtures of cyclopropane, oxygen and helium has been developed for short periods of anesthesia with the portable Reserve Midget machine.

2. At present, statistically significant data are presented for only the initial six minutes of anesthesia. Additional tests with unreported data are being compiled for periods of twelve and twenty minutes of anesthesia.

3. In 73 patients studied, initial oxygen concentrations averaged 29 per cent at the beginning of anesthesia and 23 per cent at the end.

4. The cyclopropane percentages in all cases had fallen into the safety range, below 25 per cent, after six minutes.

5. Whenever the 100 cc. soda lime canister was used with fresh material, the carbon dioxide content of the rebreathing bag remained below 3 per cent after six minutes.

6. Surgical anesthesia was induced in all cases, in either Plane 1 or Plane 2, after 6 to 12 respirations.

7. Arterial and blood gas analyses, electrocardiograms and electroencephalograms revealed no undue depression of vital physiologic function below Plane 2 of the surgical stage in any case.

RIASSUNTO E CONCLUSIONI

1. L'impiego di miscele anestetiche antiesplosive, formate da ciclopropano, ossigeno ed elio, è entrato nell'uso corrente per brevi anestesie mediante l'apparec-

chio portatile Reserve Midget.

2. A tutt'oggi si hanno dati statistici sufficienti solo al riguardo dei primi 6 minuti di anestesia; per i successivi 12 e 20 minuti ancora debbono essere elaborati i dati.

3. In 73 casi la concentrazione iniziale di ossigeno fu in media del 29% e quella finale del 23.

4. La concentrazione del ciclopropano è rimasta in ogni caso entro i limiti di sicurezza, e cioè al di sotto del 125% dopo i primi sei minuti.

5. Ogni volta che si usò soda fresca, il contenuto in anidride carbonica nell'aria espirata rimase al di sotto del 3%.

6. Si ottenne un'anestesia utile in ogni caso dopo 6-12 respiri.

7. Le analisi gasometriche, gli elettrocardiogrammi e gli elettroencefalogrammi non dimonstrarono alcuna depressione delle funzioni vitali.

RÉSUMÉ ET CONCLUSIONS

1. Des composés non explosifs de cyclopropane, oxygène et hélium ont été utilisés pour des anesthésies de courte durée (appareil de Midget).

2. Des statistiques sont présentées sur les six premières minutes de l'anesthésie.

3. Chez 73 patients les concentrations moyennes d'oxygène ont été de 29% au début et de 23% à la fin de l'anesthésie.

4. Les pourcentages de cyclopropane sont tombés au-dessous de 25% après 6 minutes.

5. Avec un mélange de 100 cc de chaux vive et d'hydroxyde de sodium, le pourcentage de dioxyde de carbone du sac respiratoire est resté inférieur à 3% après 6 minutes.

6. L'anesthésie chirurgicale a été effective dans tous les cas entre la 6éme et la 12éme inspiration.

7. Les diverses analyses, électrocardiogrammes et électroencéphalogrammes n'ont révélé aucune dépression injustifiée des fonctions physiologiques vitales.

RESUMEN Y CONCLUSIONES

1. Mediante el aparato portátil Reserve Midget se ha generalizado el uso de mezclas anestésicas no explosivas de ciclopropano, oxígeno y helio para anestesias de corta duración.

2. De momento se presentan datos estadísticos de los resultados en anestesias de hasta 6 minutos de duración. Se están recogiendo datos referentes a anestesias de 12 a 20 minutos de duración.

3. En 73 enfermos estudiados, la concentración de oxígeno al comienzo era de 29% y de 23% al final.

4. Los porcentajes de ciclopropano en todos los casos aparecen por debajo del límite de seguridad, es decir menos de 25% después de 6 minutos.

5. Siempre que se emplearon 100 c.c. de cal sodada, el contenido de anhídrido carbónico de la bolsa de respiración se mantuvo por debajo del 3% pasados 6 minutos.

6. Se consiguió siempre una buena anestesia quirúrgica bien de 1° o de 2° plano después de 6 a 12 respiraciones.

7. El estudio de gases en la sangre arterial, el electrocardiograma y el encefalograma no muestran alteración o depresión alguna de las funciones fisiológicas vitales por debajo del plano 2° del estadio quirúrgico.

ZUSAMMENFASSUNG UND SCHLUSSFOLGERUNGEN

1. Für kurze Narkosen ist die Verwendung einer nicht explosiven Mischung von Cyclopropan, Sauerstoff and Helium mit einem tragbaren Apparat (Reserve Midget) entwickelt worden.

2. Statistisch brauchbare Daten liegen zur Zeit nur für die ersten sechs Minuten der Narkose vor. Bisher unveröffentlichte Resultate weiterer Untersuchungen

bezüglich zwölf und zwanzig Minuten langer Narkosen werden jetzt zusammengestellt.

3. Bei 73 untersuchten Patienten betrug die Sauerstoffkonzentration bei Beginn der Narkose durchschnittlich 29 Prozent und am Ende 23 Prozent.

4. Die Konzentration des Cyclopropans war nach sechs Minuten in allen Fällen in den Sicherheitsbezirk von unterhalb 25 Prozent abgefallen.

5. Bei Verwendung der mit frischem Material gefüllten 100 ccm Sodakalk fassenden Büchse blieb nach 6 Minuten der Kohlensäuregehalt des Rückatmungssackes stets unterhalb drei Prozent.

6. In allen Fällen wurde nach sechs bis zwölf Atemzügen eine chirurgische Anästhesie von erster oder zweiter Tiefe erzielt.

7. Gasanalysen im Blut, Elektrokardiogramme und Elektroenzephalogramme ergaben keine Anzeichen des Bestehens unerwünschter Verminderung lebenswichtiger physiologischer Funktionen unterhalb des zweiten Niveaus des chirurgischen Stadiums.

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Correction: In the recently published program of the Northeastern Regional Meeting, the degrees F.R.C.C., F.I.C.S. and D.A.B. were erroneously ascribed to Dr. Roger Paulin of Montreal. Dr. Paulin is Chief of the Service of Surgery, St. Joseph of Rosemount Hospital; Consultant in Thoracic Surgery at St. Michael and Ste.-Jeanne D'Arc Hospitals and Thoracic Hospitals, Montreal. Sincere apologies are extended for this unfortunate error.

Lumbar and Subdiaphragmatic Aortography

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SCHOPFHEIM, BADEN, GERMANY

PERIPHERAL arteriography was developed a long time ago, but, primarily on account of technical difficulties, it is only in recent years that it has come to be used as a routine measure. Aortography, on the other hand, is still not yet in common use, although some of the references to it—by dos Santos, Demel, Loose and others—date back many years, and the development of suitable contrast media has now made it possible to apply the method on a large scale.

Doctors used to stand in awe of the technic. Until a short while ago they were often familiar only in theory with the routine application of this diagnostic method. Aortography, however, is of the utmost importance for a complete diagnostic study of the peripheral circulation, which in addition to the arteriographic

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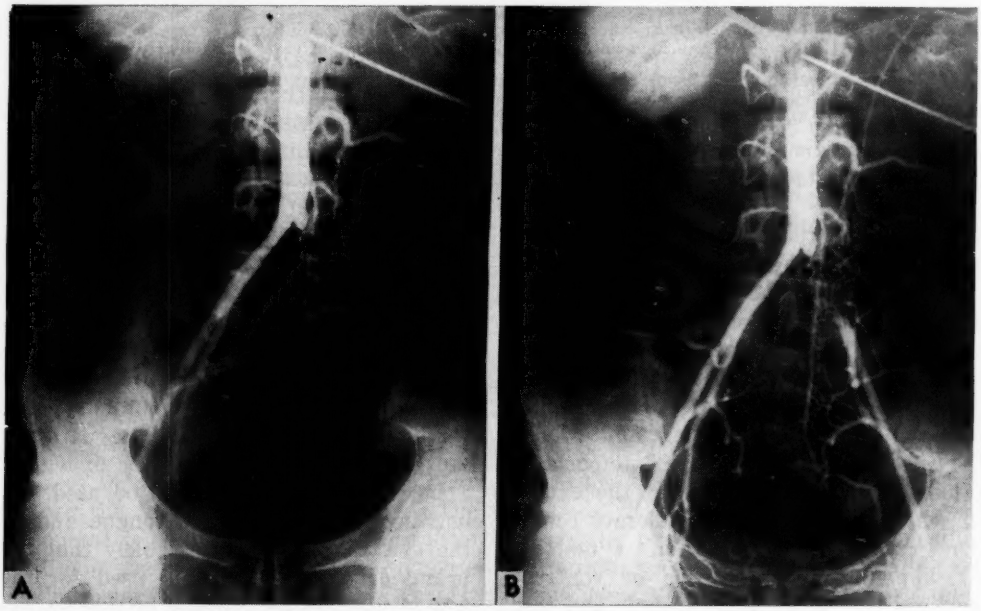

Fig. 1.—*A*, typical lumbar serial aortogram shows the point of insertion of needle and various phases of vascular filling, from region above aortic bifurcation down to upper segments of both femoral arteries. *B*, note value of serial photographs; here it may be assumed that there was complete occlusion of left iliac artery, but thanks to collateral vessels situated immediately after aortic bifurcation, external iliac can be properly filled.

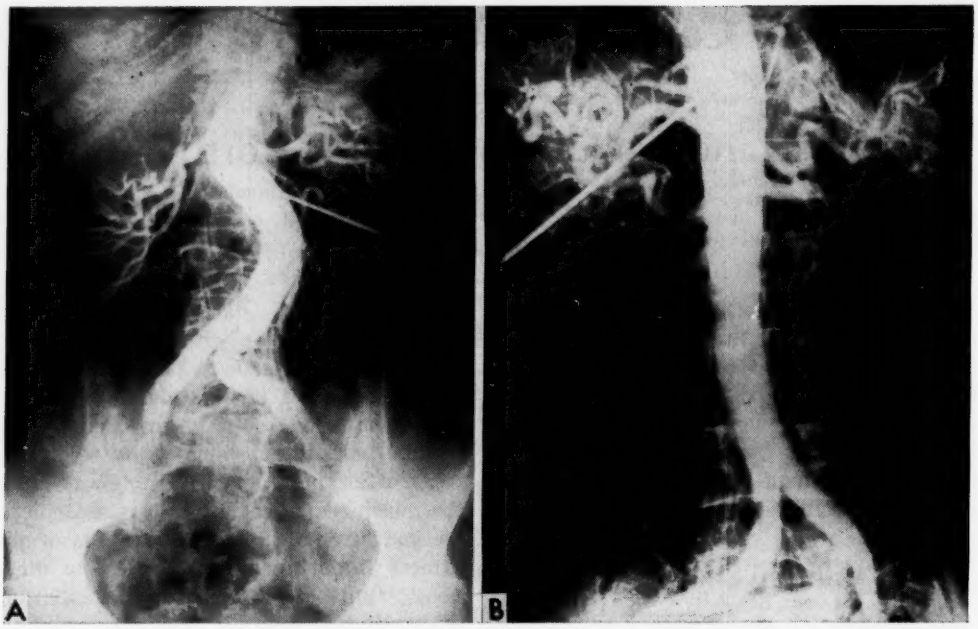

Fig. 2.—*A*, aortogram of another patient, showing pronounced elongation of aorta, which is typical of arteriosclerosis. *B*, subdiaphragmatic photograph showing incredibly high degree of definition obtainable, in which not only is the aorta completely filled, but in addition the renal arteries, the splenic artery, as well as the hepatic and inferior mesenteric arteries can be clearly visualized.

investigation, is absolutely indispensable if any surgical operation involving the blood vessels is contemplated.

As regards technic, I distinguish between lumbar and subdiaphragmatic aortographic study for visualization of blood vessels below the kidney, although the subdiaphragmatic technic must be used when it is desired to explore conditions in the region of the kidneys, spleen, and, to a certain extent, the liver as well.

A few words about the aortographic technic: As in every arteriographic study, the usual preliminary testing is important. I make it a principle to test the extent to which the patient can tolerate roentgenographic contrast media. I do this by applying a few drops of contrast medium on the patient's tongue and into the conjunctival sac. If he complains of a "burning" sensation, an alternative medium must be tried.

Contrary to the opinion, still met with in medical literature and lectures today, that the preliminary testing of contrast media is a "test of hypersensitivity to iodine," I would emphasize the following point: In all water-soluble contrast media containing iodine, the iodine is so firmly anchored molecularly that it is not released in the body. This has been corroborated in the case of Renografin by using radioactive iodine.

When I carry out a preliminary test, I am not trying to gauge the patient's sensitivity to the total molecule of whichever contrast medium is to be used. A burning sensation on the tongue and in the eye, therefore, means solely that the brand of contrast medium used for the test should not be injected in this particular instance. It does not mean that the patient is generally hypersensitive to iodine. A preliminary test with another

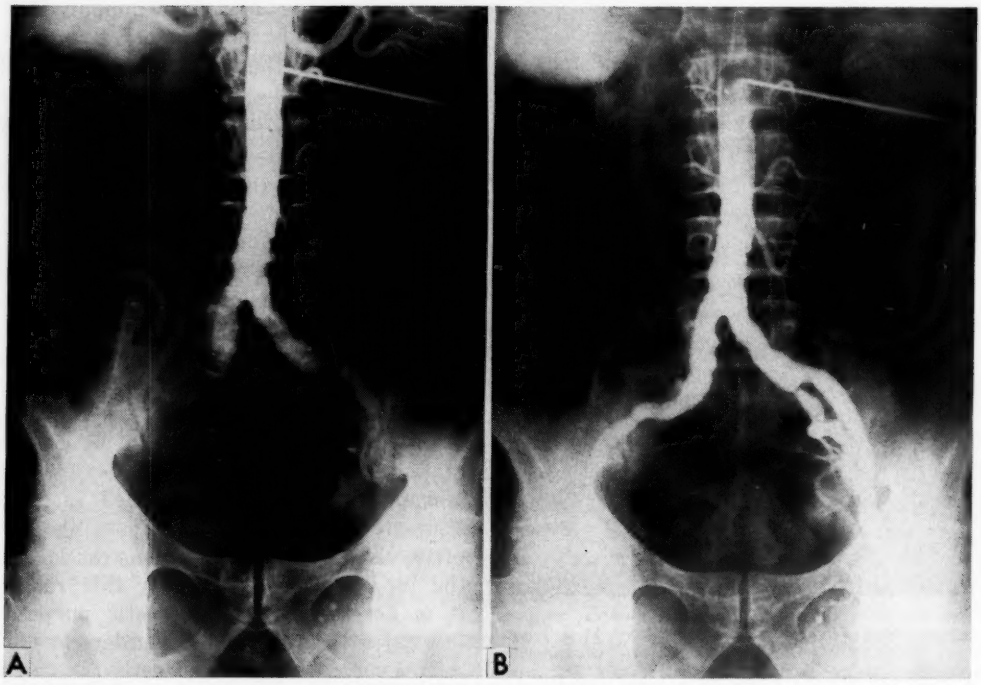

Fig. 3.—*A*, aorto-arteriogram also illustrating value of serial photographs. Lumbar portion of aorta is well filled, but one might suppose that there was block in region of common iliac arteries. *B*, one must wait for next picture to see that filling continues after the aortic bifurcation, although it is already apparent that right internal iliac cannot be visualized.

preparation from the group of tri-iodized roentgenographic contrast media will show that the group contains at least one compound whose "total molecule" is tolerated by the patient. In this connection I may emphasize the fact that I have encountered no cases of intolerance when I used a 60 per cent solution of Renografin for this purpose. This is accounted for not least by the fact that the LD equals 14.7 gm. per kilogram of body weight. 1 cc. of Dolantin is administered one hour before the aortographic procedure. The preoperative routine usually imposes little strain on the patient. For this purpose I administer Evipan, as well as a curarizing agent, in order to achieve the necessary cessation of breathing. One must, of course, be ready to administer an insufflation anesthetic immediately if required.

For subdiaphragmatic aortographic study the needle is passed along the twelfth rib toward the spinal column; once it comes into contact with bone, it is withdrawn slightly and then introduced into the aorta at a steeper angle. When a perfectly rhythmic pulsation is perceived—but not before—25 to 30 cc. of 60 per cent contrast medium, warmed to body temperature, is injected into the aorta under strong pressure, whereupon four to six serial pictures are taken in one to one and one-half seconds. (In my experience over the past years the new Schering contrast medium Urografin, or Renografin of Squibb and Sons, New York, is by far the best tolerated.) After the injection, the needle should be withdrawn immediately. For cases of lumbar aortographic study the needle is introduced transversely into the

Fig. 4.—Film showing, even more clearly, unique importance of aortography. Patient had been working full time as fitter right up to time aortogram was made. That was three years ago, and the man is still able to practice his trade today. Aortogram shows complete occlusion of entire right common iliac, as well as internal and external iliac on right side. Fortunately, however, there were such wonderful possibilities of collateralization via inferior mesenteric, hemorrhoidal artery, and pudendal vessels that, astonishingly enough, right femoral artery could again be well filled and visualized. With aid of sustained medical supportive treatment aimed at maintaining collateral vessels, it was thus possible to save leg. Subdiaphragmatic aortography in particular, the technic of which I have just demonstrated, is assuming increasing importance in assessment of renal lesions, in the widest sense of the term. Here, too, serial photographs are essential, for only in this way can one visualize properly all different phases—arterial, venous, and parenchymatous—of blood flow through kidney.

aorta, a hand's breadth to the side of the spinal column and approximately at the level of the second lumbar vertebra; as with the subdiaphragmatic method, the needle, after reaching the spinal column and being withdrawn slightly, penetrates into the aorta at a somewhat steeper angle.

The method of performing an aortographic study by introducing a vinyl catheter into the groin and then pushing it up into the aorta is also commonly used in some hospitals. It cannot be applied, however, when there is partial or total obliteration of the blood vessels in this area; in other words, the most interesting pictures cannot be taken.

It is, of course, absolutely necessary that the diagnosis should be established only on the basis of a serial aortogram. To arrive at an accurate renovasographic and aortographic diagnosis, however, it is essential above all to visualize the rhythmic pattern of the blood flow through both kidneys and through the lumbar portion of the aorta, together with its more distant branches. A single aortographic recording will always provide only a momentary picture of a limited vascular segment and is incapable of insuring complete visualization of all the vessels and the renal parenchyma. For this reason it is necessary, for diagnostic purposes and prior to surgical intervention, to take a total vasogram in one operation, whether the approach is subdiaphragmatic or lumbar. The total vasogram shows, phase by phase, how the contrast medium fills the renal vascular tree and penetrates into its fine terminal branches; there are three main phases—arterial, parenchymatous and venous. Such aortograms and, especially, renovasograms, provide insight into the pathologic, anatomic and functional pictures that may serve as a basis for more extensive studies of renal diseases and for their surgical treatment.

To obtain the necessary serial vasograms I have just described, a special apparatus had to be designed. Thus, for instance, investigators in Germany for years have been using an aortographic apparatus which, thanks to an automatic cassette coupled to the roentgen tube, can take up to two pictures a second and a total of eight pictures.

I myself have improved upon this device by adding a simple preselector which en-

ables the various exposure times to be more closely adapted to the expected velocity of the blood flow.

An apparatus has now been developed which is driven quite automatically by means of a particularly powerful motor;

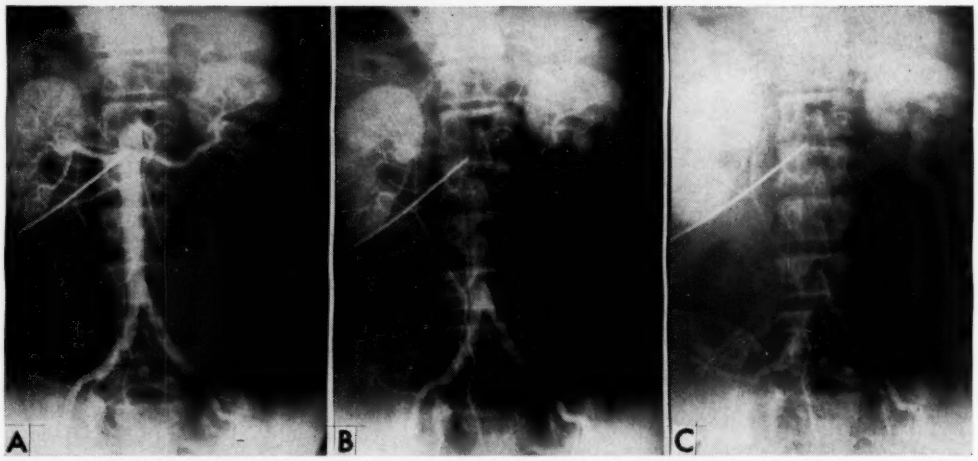

Fig. 5.—*A*, needle in horizontal position near renal arteries. Besides illustrating progressive filling of the aorta, this picture shows clearly arterial phase in both kidneys. *B*, transition to the venous phase; *C*, finally, parenchymatous phase, particularly on right side.

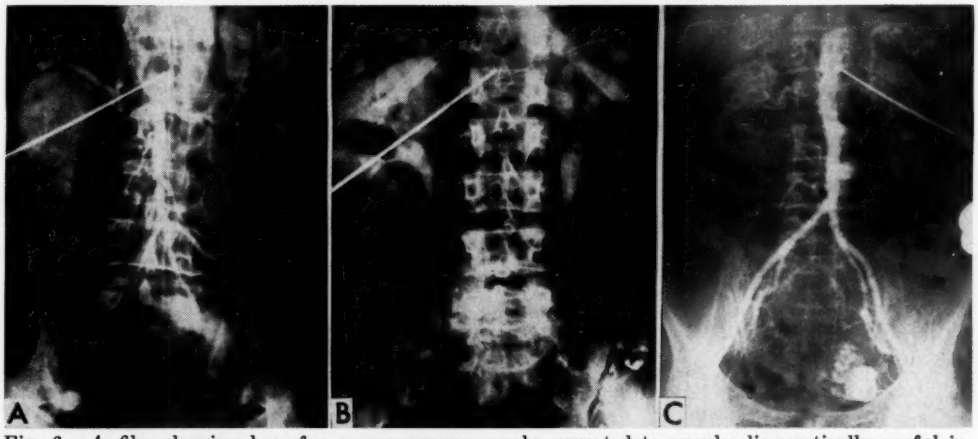

Fig. 6.—*A*, film showing how far renovasogram can be expected to supply diagnostically useful information regarding size, position, and arterial blood supply of kidneys. Splenic artery, with its wide lumen, is also filled with contrast medium. In this patient, kidneys are of normal size but are not in the normal position relative to one another, nor are they filled with contrast medium to same degree. Whereas renal arteries on right side are still filled and transition from the arterial to the parenchymatous phase is apparent, purely parenchymatous phase has already been reached in left kidney. I have very frequently observed in renovasograms this marked difference in time taken by the contrast medium to fill arterial and the venous vascular tree. *B*, urographic visualization, now possible, shows phase of total excretion through calices and pelvis of kidney and into ureters. These excretion urograms are obtained by taking additional photographs two to five minutes after completion of subdiaphragmatic aortographic study. *C*, photograph showing multiple small aneurysms in region of the lumbar portion of aorta and iliac branches. Subdiaphragmatic aortography assumes particular importance in diagnosis of wide variety of renal tumors. Aortogram now facilitates differential diagnosis of such tumors and in particular, makes it possible to distinguish between hydronephrosis, hypernephroma, cystic kidney, etc.

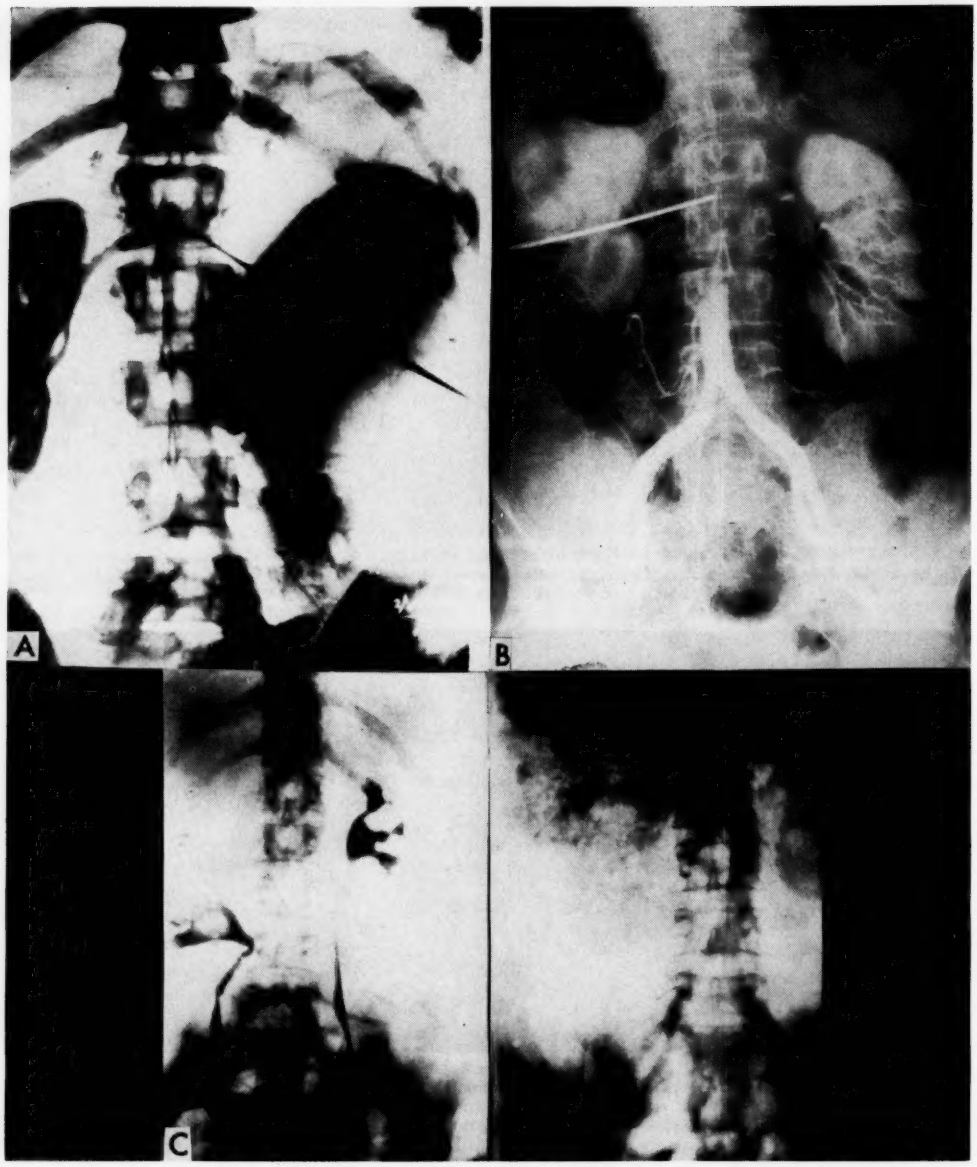

Fig. 7.—*A*, subdiaphragmatic aortogram revealing typical hydronephrosis. Arteries of right kidney show up normally and well, while left kidney appears large and transparent and blood vessels are outlined only at periphery. Here, too, it is clear that only serial vasograms can present decisive picture. Aortography is still more important as an aid to diagnosis of malignant renal processes. *B*, one or other of kidney vessels are not outlined therefore, owing to presence of destructive renal processes. Also, hypernephroma can now be perfectly diagnosed preoperatively simply by using subdiaphragmatic aortography. *C*, large hypernephroma on right side, in spite of retrograde pyelogram, cannot be exactly diagnosed, while blurred filling of entire kidney—which appears enlarged here owing to high vascularization of tissues—is characteristic.

it takes the photographs from the aorta to the foot in one operation.

In all these aortograms Renografin 60 per cent, made by Schering (represented by E. R. Squibb & Sons in the United States) has been used.

And now a few words about the dangers of aortographic study. The method is certainly highly differentiated, but equally certainly it is not entirely safe. It should be used, therefore, only when the presence of certain symptoms or the type of diagnosis expected render such an investigation necessary. As a matter of principle, one should always consider in advance the possibility of some degree of hypersensitivity. Injuries to the spinal column, and even to the spinal canal, have been described. I myself have encountered no untoward incidents of this nature.

Para-aortic paravasation is the most frequent accident, at least when the method is applied by persons unpracticed in its use. This can, to be sure, cause extremely severe pain. In all the cases known to me, however, this pain has subsided quite spontaneously after a few hours. I usually carry out the aortographic study with the patient under general anesthesia, a precaution that may be considered advantageous in the event that this complication occurs, as experience has shown that the shock may otherwise be considerable. Situations likely to endanger life have never arisen as a result of paravasation.

Another complication to be feared is excessive secondary bleeding from the side on which the puncture is made. Personally, I have not encountered any such complication. Because of this possible danger, prior administration of anticoagulants is definitely contraindicated. I have frequently had the opportunity to examine at autopsy the extent of an extravasation. Even in cases of the most severe arteriosclerosis this extravasation

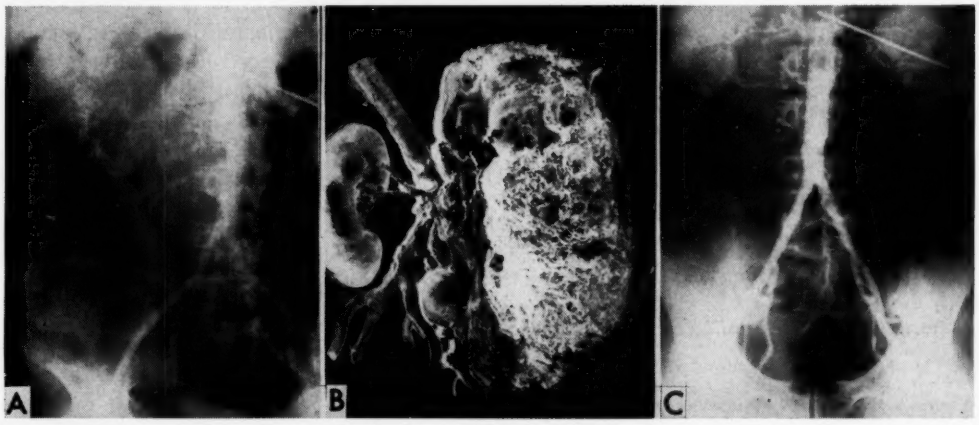

Fig. 8.—*A*, retrograde pyelogram again incapable of clarifying picture. It might be thought that nothing at all can be visualized, but in actual fact extensive hypernephroma exists on right side; nevertheless, blurred outlines are characteristic. *B*, anatomic specimen of tumor. Only now can one observe extent of tumor and its proliferation into aorta; apparently normal left kidney has already doubled in size as a result of active hyperplasia. Aortography is also important for diagnosis of tuberculous lesions in renal region. In this field, too, prospects of determining exact location of foci in advance will be far greater in future. This will also make it possible to apply much more differentiated treatment (partial resections or the like). In the following case I was able to prove presence of tuberculous focus in one particular area of kidney simply by using subdiaphragmatic aortography. With the methods commonly used in the past, and also applied in the case of this patient, it had been impossible to make such a diagnosis. *C*, visible gap at left lower pole of kidney, through which otherwise normal blood flow does not pass and which is presumably diseased.

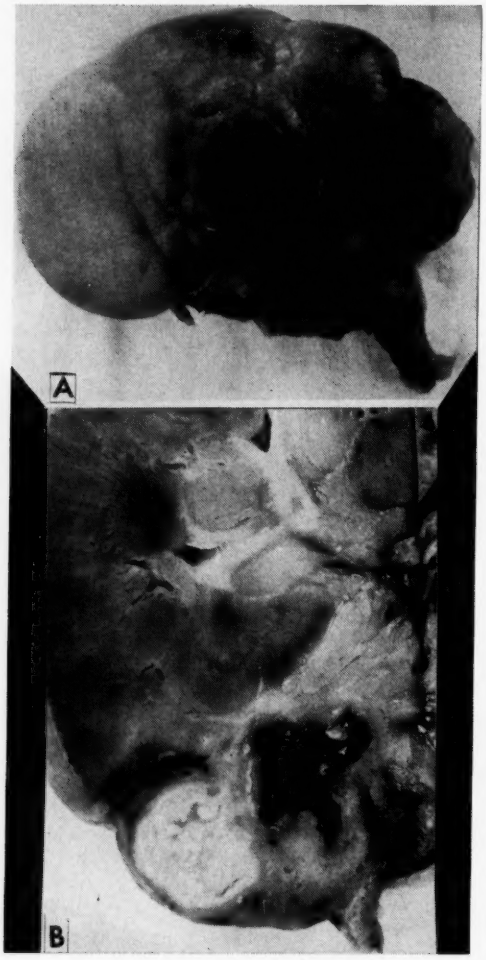

Fig. 9.—*A*, evidence that after dissection of kidney during operation no other localization of the focus was possible. Only by means of sliced specimen (*B*) was it possible to prove presence of tuberculous disease in region of left lower renal pole, identical with bracketing in the precedent aortogram. It is not yet possible to estimate full importance of this method for exact diagnosis of partial deficiencies in individual areas of kidneys; its use, however, will probably enable large healthy portions of kidneys to be more or less completely spared.

was always slight, not amounting to more than about 15 cc. A further question is the possibility of damage to the intima, caused by the puncture itself or by the injection of a highly concentrated contrast medium. Here, too, I have been able to make a wide variety of postmortem studies on sections. Regardless of whether the injection had been given a short time before the autopsy or many weeks before, neither macroscopic nor microscopic changes in the intima could be detected.

It is true that if the highly concentrated contrast media are injected into the small subsidiary blood vessels, e.g., of the renal, splenic or mesenteric arteries, there may be some risk of thrombosis or damage to the vascular wall. At least, such lesions have been described in the literature. I myself have not observed any subjective symptoms or any objective changes in the kidneys, even when the renal artery had been punctured by mistake or in various other and similar situations.

At the Seventy-Second Meeting of the German Section of the International College of Surgeons, Loose described a number of faulty punctures of the trunk vessels, including his own cases and those referred to in the literature. In these cases the needle was mistakenly introduced into the renal artery, the celiac trunk, the superior mesenteric, the inferior mesenteric and the common iliac artery. Serious incidents could always be avoided, however, since the contrast medium was never injected into the vascular pathway with the aid of a high-pressure instrument. I myself have never used such an instrument either.

To sum up, it can be said that, with the aid of a nonirritant, iodine-containing contrast medium, a simple injection technic and progressive angiographic roentgen examination, it is possible to visualize objectively on roentgenograms all active vascular lesions of functional and organic origin in the region of the pelvis and the kidneys.

By combining aortographic study with the other clinical methods of examination in common use, one can substantially

extend one's knowledge of the disease processes in the vascular regions aforementioned.

SUMMARY

It is only in recent years that aortography has come to be used to an increasing extent as a routine measure for the diagnosis of important lesions in the aorta and its branches, as well as in the kidneys, spleen and liver.

There are various methods of carrying out aortographic studies—including, in particular, the lumbar and the subdiaphragmatic technic, with puncture of the aorta from the paravertebral aspect. When the author employs this method, he administers Evipan anesthesia and a muscle relaxant. The contrast medium used is Urografin, produced by Schering, or Renografin, which is manufactured under license by E. R. Squibb and Sons, New York.

Serial aortograms are extremely important, since without their assistance grave errors in diagnosis may arise. A number of illustrations are presented, showing a wide variety of vascular deficiencies. Subdiaphragmatic aortographic examination is especially suitable for complete visualization of the different functional phases in the kidney. By using this new method in preference to the old, one can achieve better visualization of abnormal vascular conditions, cyst formation, hydronephrosis and hypernephroma; tuberculous lesions and the like also show up with particular clarity.

The dangers of aortographic investigation and its contraindications are likewise discussed in detail, and the question of faulty punctures is gone into thoroughly. The routine application of aortographic study offers considerable assistance in establishing a definite diagnosis and thus facilitates a differentiated approach to surgical treatment.

ZUSAMMENFASSUNG

Erst in den letzten Jahren besteht eine zunehmende routinemässige Anwendung der Aortographie zur Diagnostik wichtiger Veränderungen im Bereich der Aorta und ihrer Nebenverzweigungen, sowie der Nieren, Milz, Leber usw.

Zur Durchführung der Aortographie stehen neben verschiedenen anderen Methoden, insbesondere die lumbale und subdiaphragmale Aortographie mit Punktion der Aorta von paravertebral her und unter Anwendung einer Evipan-Narkose, sowie eines muskelerschlaffenden Mittels zur Verfügung.

Als Kontrastmittel wurde das von der Fa. Schering hergestellte Präparat Urografin bzw. das von der Fa. E. R. Squibb & Sons, New York hergestellte Renografin angewandt.

Ausserordentlich wichtig ist die Verwendung von Serien-Aortogrammen, da gerade ohne diese folgenschwere Fehlschlüsse entstehen können. Die subdiaphragmale Methode eignet sich besonders zur lückenlosen Erfassung des funktionellen Phasenablaufs in der Nierendarstellung. Hier können wir besser, als mit den alten Methoden abnorme Gefässanlagen, Cystenbildungen, Hydronephrosen, Hypernephrombildungen, aber ganz besonders schön auch tuberkulöse Veränderungen und dergleichen zur Darstellung bringen. Auch werden Gefahren, Kontraindikationen der Aortographie, sowie Fehlpunktionen im einzelnen besprochen. Die routinemässige Anwendung der Aortographie schliesst eine wesentliche Lücke bezüglich diagnostischer Unklarheiten und führt damit zu differenzierten chirurgischen Möglichkeiten.

RESUMEN

Sólo en los últimos años ha venido utilizándose en escala mayor la aortogra-

fía como medida rutinaria para el diagnóstico de lesiones importances de la aorta y sus ramificaciones así como de los riñones, del bazo, del hígado, etc.

Hay varios métodos para practicar la aortografía—incluyendo especialmente la técnica lumbar y subdiafragmática con perforación de la aorta desde el aspecto paravertebral; al emplear dicho método, aplico el anestésico Evipán y un relajante para los músculos.

El medio de contraste utilizado es el urografin, elaborado por la casa Schering, o el Renografin, fabricado bajo licencia por la casa E. R. Squibb & Sons de Nueva York.

Los aortogramas *de serie* son sumamente importantes pues sin la ayuda que ofrecen pueden ocurrir graves errores en el diagnóstico. Se muestran diversas ilustraciones explicando la gran variedad de deficiencias vasculares. La aortografía subdiafragmática es indicada especialmente para la visualización completa de las diferentes fases funcionales en el riñón. Al emplear este método de preferencia a los anteriores, obtenemos mejor visualización de las condiciones vasculares anormales, de la formación de quistes, de la hidronefrosis y del hipernefroma; también preséntanse con excepcional claridad las lesiones tuberculosas y condiciones análogas. Se trata detalladamente de los peligros de la aortografía y de sus contraindicaciones, y se somete a un examen cuidadoso el problema de las perforaciones defectuosas. La aplicación rutinaria de la aortografía representa una considerable ayuda al establecer un diagnóstico definitivo, llegándose así a posibilidades quirúrgicas distintas.

RIASSUNTO

Solo in questi ultimi anni si è verificato un maggior impiego corrente dell'aortografia per la diagnosi di importanti mutamenti nel complesso dell'aorta e delle sue diramazioni, come pure dei reni, della milza, del fegato ecc.

Oltre a diversi altri metodi atti all'esecuzione dell'aortografia, si può citare in particolar modo l'aortografia lombare e subdiaframmatica con punzione paravertebrale dell'aorta mediante narcosi a base di Evipan come pure a base di un prodotto d'azione rilassante muscolare.

Quale farmaco di contrasto venne adottato l'Urografin della ditta Schering, rispettivamente il Renografin della ditta E. R. Squibb & Sons di Nuova York.

L'impiego di aortogrammi in serie è di particolare importanza poichè solo con tale sistema si possono evitare errate conclusioni non prive di conseguenze anche gravi. Il metodo subdiaframmatico si presta specialmente per stabilire in modo completo ed ininterrotto lo sviluppo delle fasi funzionali dei reni. Meglio che tutti i metodi antiquati, tale sistema permette di illustrare le disposizioni organiche anormali, la formazione di cisti, le idronefrosi, le formazioni ipernefromiche ed in modo particolarmente chiaro anche i mutamenti d'origine tubercolotica. Vengono con ciò trattati in modo circostanziato i vari pericoli, le controindicazioni dell'aortografia nonchè l'eventualità di errori derivanti dalle punzioni. L'impiego corrente dell'aortografiia pone termine ad una lacuna risultante dalle imprecisioni diagnostiche permettendo con ciò di arrivare a possibilità chirurgiche ben determinate.

SUMARIO

E só nos ultimos anos que se tem verificado um aumento na aplicação de rotina da aortografía para o diagnostico de importantes transformações no domínio da aorta e suas ramificações, assim como dos rins, baço, figado etc.

Existem diversos métodos para aplicar a aortografía inclusive, e em particular a

tecnica lombal e subdiafragmatica com punção da aorta do ponto de vista paravertebral; quando utilizado este método administra-se uma anestezia de Evipan e um relaxante dos musculos.

O remedio de contraste usado é o Urigraphine, produzido pela Firma Schering, ou Renographine o qual é fabricado sobre licença pela Firma E. R. Squibb & Sons, New York.

Os aortogramas *em serie* são extremamente importantes, pois graves erros de diagnostico podem ocorrer sem a observação dos mesmos. Mostra-se um numero de illustrações, demonstrando uma ampla variedade de deficiencias vasculares. A aortografía subdiafragmatica é particularmente indicada para um completo conjunto visual das diferentes fases funcionais nos rins. Usando este método em preferencia aos antigos, pode-se obter um conjunto visual melhor sobre condições vasculares anormais, formação de cistos, hidronefrite e hipernefroma; lesões tuberculosas e outras aparecem-tambem particularmente claros. Os perigos da aortografía e suas contra-indicações são igualmente discutidos em detalhe, e a questão de punções erradas é estudada minuciosamente. A aplicação rotineira da aortografía é de assistencia consideravel em estabelecer diagnosticos definitivos e assim facilita a escolha do tratamento cirurgico.

RÉSUMÉ

Ce n'est que ces dernières années que l'aortographie a commencé à être de plus en plus utilisée comme procédé courant pour le diagnostic d'importantes lésions de l'aorte et de ses branches, ainsi que du rein, de la rate, du foie, etc.

Il existe diverses manières d'appliquer l'aortographie, y compris, en particulier, la technique lombaire et subdiaphragmatique avec ponction de l'aorte du point de vue paravértébral; lorsque j'utilise cette méthode, j'administre une anesthésie à l'Evipan et un relaxant des muscles.

L'agent de contraste utilisé est l'urigraphine, produite par la maison Schering, ou la Senographine, fabriquée sous licence par la maison E. S. Squibb & Sons, New York.

Les aortogrammes *en série* sont extrêmement importants, car de graves erreurs de diagnostic peuvent se produire si l'on n'y a pas recours. On voit un certain nombre d'illustrations représentant une grande variété de déficiences vasculaires. L'aortographie subdiaphragmatique est particulièrement indiquée pour permettre une vue d'ensemble complète des différentes phases fonctionnelles dans le rein. En utilisant cette méthode de préférence aux anciennes, on peut obtenir une meilleure vue d'ensemble des conditions vasculaires anormales, formation de kystes, hydronéphroses et hypernéphromes; les lésions tuberculeuses et autres apparaissent également de manière particulièrement nette. Les dangers de l'aortographie et de ses contreindications sont aussi discutées en détail, et la question des fausses ponctions est étudiée de manière approfondie. L'application courante de l'aortographie représente une aide considérable pour l'établissement d'un diagnostic definitif, et facilite ainsi le choix du traitement chirurgical.

Genitourinary Surgery

Bilateral Complete Ureteral Duplication

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URETERAL anomalies occur in many variations from the normal. Bilateral ureteral agenesis is incompatible with life, and Campbell[1] collected only 7 instances in 19,046 autopsies on children, while unilateral ureteral agenesis occurred at a ratio of 1:552. Ureteral triplication is one of the rarest ureteral anomalies. Smith[2] collected only 13 cases, in 1 of which the condition was bilateral, and Begg[3] added an additional case. Duplication of the ureter is not uncommon and occurs in several forms; incomplete, complete, unilateral, bilateral and mixed.

The commonest form of incomplete ureteral duplication, the "y" ureter, is one that unites in the upper third; less common is union in the middle third; while juncture in the lower third (or in the intramural portion of the ureter) is most infrequent. If the double ureters empty separately, then a much rarer condition occurs, called complete ureteral duplication. When complete ureteral duplication is present bilaterally there will be four kidneys, four ureters and four orifices.

The "inverted Y" ureteral anomaly is a rare condition in which a single ureter branches or divides before it reaches the bladder, so that two orifices drain a single ureter. Therefore, when two ureteral orifices are seen cystoscopically on the same side of the trigone, a double ureter and a double kidney are not necessarily present above.

When complete ureteral duplication occurs, the major orifice is located in the normal position on the trigone and drains the lower or major kidney. The minor ureter emerges from the minor or superior kidney, crosses the major ureter and enters the bladder medial and usually distal to the major orifice. This constant relation between the major and minor ureters and their orifices was described by Weigert[4] (1877) and R. Meyer (1907), though a few exceptions to the "Weigert—R. Meyer Law" have been reported.[5] If the ureteral buds were far enough apart during fetal development the minor orifice may be in the posterior urethra; or in the ejaculatory duct of the male; or in the cervix or vagina of the female.

The term "reduplication" is a misnomer as occasionally seen[6] in the literature and should not be used, since duplication means to double (i.e. $2 \times 1 = 2$), while reduplication means to "redouble" (i.e. $2 \times 2 = 4$). Therefore, it is incorrect to speak of "ureteral reduplication" unless four ureters are present on the same side, a condition not reported as such in the literature. Begg's[3] unique case of "sextuplicitas renum," as he termed the condition, could be classified as "right ureteral duplication and left ureteral reduplication."

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Kerr[7] in 1911 called attention to the duplicated ureter in a report on 5 cases of the unilateral condition. Mertz[8] in 1920 and Harpster and his associates[9] in 1922 were able to collect from the literature only 40 cases of bilateral duplication. By 1939, Mills,[10] in a comprehensive survey of the literature, certified 850 collected cases as involving some type of ureteral duplication, and of these duplications 96 were bilaterally complete. Apparently, at the time of writing, only about 150 cases of this type have been reported in the literature published in the English language.[11]

Statistical studies as to the frequency of these various ureteral anomalies are misleading, because the rare conditions are reported and the more common ones are not.[12] In a careful study of 51,880 autopsies, however, Campbell[1] noted ureteral duplication in 342 instances, in 101 of which there was complete duplication, though only 4 of these were bilaterally complete. The incidence of bilateral complete ureteral duplication, therefore, is 1 : 12,970.

Embryologic Background. — The pronephric tubules appear in the 2.5 mm. embryo during the third and fourth weeks, and soon fuse with the cloacal wall. Between the fifth and sixth weeks the urogenital septum passes downward to divide the cloaca into the rectum dorsally and the urogenital segment venturally. During this stage the ureteral buds appear on the dorsum of the mesonephric or wolffian ducts, enter the ventral cloaca, and grow cephalad to dilate and eventually form the renal pelvis and calyces. Thus the ureteral buds ultimately form the urine-collecting system and, with the wolffian duct, become the vesicourethral analge. During the seventh week the ureteral orifice forms the lateral angle of the trigone, while the distal end of the wolffian duct becomes the posterior portion of the urethra. In the male the wolffian duct forms also the vas deferens, the epididymis and the seminal vesicle. Abnormal development of the ureteral buds and the wolffian derivatives produce ectopic ureteral orifices, which may open into the posterior portion of the urethra or the seminal vesicle in the male or into the urethra, vagina or cervix in the female.[13]

A condition called ureteral ectopia occurs when the ureteral orifice opens distal to the bladder. In the male the ectopic ureter ends proximal to the external urinary sphincter, while in the female the reverse is true. When ureteral ectopia is present, therefore, the male is continent and the female incontinent of urine.

Campbell[1] listed two possible explanations for the embryonic development of ureteral duplication: (1) the development of two ureteral buds, with fusion of the nephrogenic analgen (double kidney) or without fusion (supernumerary kidney), and (2) fission or splitting of a single ureteral bud.

The first theory explains the bilateral complete duplication and the unusual location of the extra orifices, but does not explain the incomplete duplication usually seen. The second theory does not explain the "inverted Y" ureter, and no present theory explains all varieties of ureteral malformations.

Symptoms and Diagnosis. — Ureteral anomalies predispose to urinary stasis, infection and calculous disease. Before the discovery of the roentgen ray and the invention of the cystoscope these anomalies were diagnosed only at operation or at autopsy.

The early recognition of duplicated ureters in a patient may not necessitate immediate surgical intervention, but the condition can be studied and the patient educated to return for periodic follow-up examinations. Thus, if and when an operation does become necessary, renal tissue

can be saved by early accurate diagnosis. If the patient when first seen has a damaged segment of a double kidney, this can be removed by heminephrectomy, with or without removal of the involved ureter. Urologists have insisted for years that early heminephrectomy[14] is a conservative operation, while nephrectomy performed later, owing to delay, is radical. The unfortunate patient with minimal recurrent hematuria, pyuria, pain, backache and "dyspepsia" may not seek medical attention or may have an unobservant physician. An undiagnosed ureteral duplication, therefore, may allow irreparable damage to occur in both segments of a double kidney and necessitate nephroureterectomy.

The importance of pus and/or blood in the urine is appreciated by many physicians who utilize intravenous pyelographic study as part of a diagnostic routine. When anomalous ureteral and/or renal conditions are suspected, an early accurate diagnosis can be made by retrograde pyelographic, cystographic, bulb ureteropyelographic investigations and other specialized technics available to urologists.

A person with ureteral duplication may have pain, which may be dull or sharp, intermittent or constant, and which is located in the lower part of the abdomen, the flank or the costovertebral area. Usually an ache low in the abdomen is attributed to the tubes, uterus and ovaries in the female, to the prostate in the male or to the colon in either sex. The differential diagnosis of pain should take account of the ureter as a possible source when the pain is low in the abdomen and radiates to the genetalia. If stricture is present, the ureteropyelogram will show the dilation proximally and perhaps the actual stricture. Anatomically the normal ureter is slightly narrowed at the ureteropelvic juncture, more narrowed at the brim of the pelvis and narrowest at the ureterovesical juncture. The completely duplicated ureters may be obstructed most often at these sites, while the incompletely duplicated ureters usually become obstructed at their point of juncture.

Fig. 1 (Case 1).—Retrograde pyelogram of Mrs. J. D. C.

REPORT OF CASES

CASE 1 (Fig. 1).—Mrs. J. D. G., white woman aged 26, was seen on Feb. 11, 1957, because of pyuria, nausea, vomiting, as well as pain in the right loin. A complete urologic study revealed a tight urethral stricture, inflammation of the vesical mucosa, and four ureteral orifices. Pyelographic investigation with a catheter up each ureter showed normal upper and lower right kidneys and a normal lower left kidney. The upper left kidney was poorly outlined. Cultures of urine showed Alkaligenes faecalis in all four kidneys. Sensitivity tests revealed these organisms to be sensitive to tetracyclin derivatives, Mandelamine and Polymyxin.

When seen again on October 10 the patient was pregnant, so a recheck pyelographic study was not done. In the meantime, urethral dila-

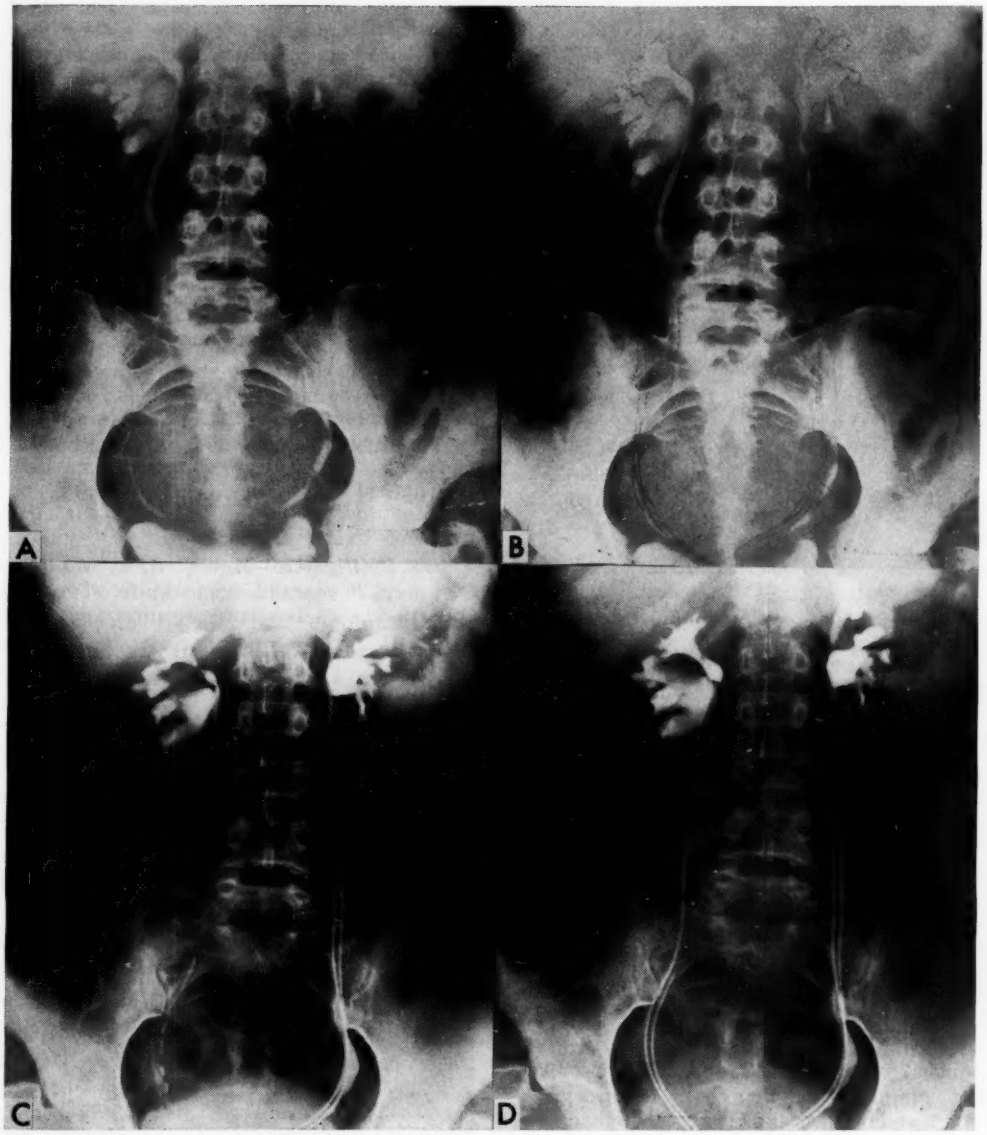

Fig. 2 (Case 2).—Films taken in case of Mrs. E. R. *A*, fifteen-minute intravenous pyelogram. *B*, composite drawing on roentgenogram. *C*, retrograde pyelogram. *D*, spliced left and right pyelogram, showing four kidneys and four ureters.

tions and oral treatment by a local physician had relieved the original complaints.

CASE 2 (Fig. 2).—Mrs. E. R., a white woman aged 33, was first seen in Aug. 9, 1957, complaining of hematuria, burning, pyuria and muscular aching. These symptoms had occurred three times during the past few months. Dr. Elgin Ware of Dallas, Texas, had per-

Fig. 3 (Case 3).—Retrograde pyelogram of Mrs. C. L. B.

formed a transurethral resection of the bladder neck in 1953. A complete urologic study showed urethral stenosis; the posterior portion of the urethra was entirely normal (showing a good transurethral bladder neck resection previously); trabeculations were Grade II, and small diverticula were present throughout the bladder. The four ureteral orifices were catheterized, and pyelograms showed four separate kidneys, with slight pyelonephritic changes in both left kidneys. Cultures of urine from all kidneys were sterile. The patient returns every three to four months for urethral dilation and remains urologically symptom-free.

CASE 3 (Fig. 3).—Mrs. G. L. B., a white woman 33 years old, was seen on May 24, 1955, complaining of pain in both costovertebral angles and blood in the urine. There had been no previous urologic trouble and no difficulty with two pregnancies several years before. A complete urologic workup was done, with pentothal anesthesia, and revealed a tight meatus, granular polypoid posterior urethritis, a contracted vesical neck and generalized acute cystitis. Four orifices were present, and retrograde pyelographic study showed bilateral complete ureteral and renal duplication. E. coli was cultured from specimens of urine from the bladder, upper right kidney and lower left kidney, while Pseudomonas was observed in that of the upper left kidney. The urine of the lower right kidney urine contained no organisms. The patient has remained symptom-free, according to her mother, who also is a patient.

CASE 4.—Mrs. I. S., a white woman aged 47, was seen in July 1944, with pyuria and low grade fever of several days' duration. For many years she had suffered from intermittent backache. Examination revealed four ureteral orifices, low grade chronic cystitis, and cystitis cystica involving the floor of the bladder. Retrograde pyelographic study showed stones in each of the small intrarenal pelves. Since no obstruction was present, and since the pyuria responded to one of the sulfa preparations, no operative procedure was advised. The patient was seen four years later and reported that there had been no urologic symptoms during the interval.

CASE 5 (Fig. 4).—Mrs. C. B. H. was first seen as a 20-year-old single white woman in June 1949, with frequency, dysuria and back-

Fig. 4 (Case 5).—Twenty-minute intravenous pyelogram of Mrs. C. B. H.

ache. Intravenous and retrograde pyelographic studies on several occasions showed four ureters and four kidneys. The upper pole kidneys were rudimentary. Catheterization of the ureters to both upper kidneys reproduced and later relieved the more or less constant abdominal pain of which she had complained since childhood. Marriage in 1950 and two pregnancies have occurred without any urologic complication. The patient is seen periodically, and, except for mild recurrent backache, remains in good health.

SUMMARY

Ureteral anomalies occur in many and bizarre forms. Bilateral ureteral agenesis is extremely rare and incompatible with life. The unilateral type occurs in about 2 out of 1,000 births. Ureteral triplication has been reported in only 14 cases.

Incomplete ureteral duplication, or "Y ureter," is not uncommon. The two ureters join, usually in the upper third, occasionally in the middle third and rarely in the lower third, to form a single ureter to the bladder.

Two ureteral orifices on the same side do not necessarily mean complete ureteral duplication, as there are reports of the inverted "Y ureter" connected to a single ureter and kidney above. This condition is difficult to explain embryologically.

Complete ureteral duplication develops from two ureteral buds in the fetus and may occur with a double kidney or, rarely, with a supernumerary kidney. Ureteral duplication is considered complete when there are two ureteral orifices on the same side. The major ureter (from the lower kidney) lies in the usual position on the trigone, while the minor ureter (from the upper kidney) exits medially and usually distally. This minor orifice may open in the bladder or the posterior portion of the urethra; or, in the male, into the seminal vesicle and, in the female, in the cervix, uterus or vagina. This ectopic ureteral orifice in the female will be external to the sphincter, so the patient will be incontinent of urine.

The term "reduplication" should be reserved for cases in which there are four ureters on the same side, a condition not reported thus far in the literature.

The embryologic background of the normal and the duplicated ureter is described. At present, no satisfactory theory explains all types of ureteral duplication.

Anomalies of the urinary tract predispose to urinary stasis, infection and calculous disease. The diagnosis of ureteral duplications should be made early, so that, when indicated, conservative operation can save renal tissue. Specialized roentgen technics and urologic procedures will aid in early diagnosis.

Five new cases of bilateral complete ureteral duplication occurring in female patients are reported. In 1 case, nonobstructing stones were present in each of the four intrarenal pelves.

RESUMEN

Las anomalías ureterales se presentan en las formas más raras. La agénesis ureteral bilateral es rarísima e incompatible con la vida. El tipo unilateral se suele presentar en 2 de cada 1.000 nacimientos. Solo hay referencia de 14 casos de triplicación ureteral.

No es infrecuente la duplicación ureteral incompleta o "ureter en Y." Los dos uréteres aparecen juntos casi siempre en el tercio superior, a veces en el medio y raramente en el inferior para acabar formando un solo uréter al llegar a la vejiga.

Dos orificios ureterales en un mismo lado no significan necesariamente una duplicación ureteral completa pues pueden corresponder a un ureter en Y invertido procedente de un solo uréter y riñón. Tal afección es difícil de explicar embriológicamente.

La duplicación ureteral completa se desarrolla a partir de dos mamelones ureterales en el feto y puede coincidir con un riñón doble o más raramente con un riñón doble o supernumerario. El uréter mayor (del riñón más bajo) asienta en la porción normal en el trigono, mientras que el ureter menor (del riñón más alto) aparece por lo general medial y distalmente. Este orificio del menor puede abrirse en la vejiga o en la porción posterior de la uretra, o, en el hombre, en la vesícula seminal, o, en la mujer, en el cuello, en el útero o en la vagina. Este orificio ureteral ectópico en la mujer puede ser extraexfinteriano y acompañarse de unsuficiencia urinaria. El término "reduplicación" debiera reservarse para casos de cuatro uréteres en el mismo lado, una condición disconocida hasta la fecha en la literatura:

Se descubre el fundamento embriológico de los uréteres normales y duplicados. Las anomalías del tracto urinario predisponen a la estasis urinaria, a la infección y a la urolitiasis. El diagnóstico de las duplicaciones urinarias debe hacerse precozmente ya que, cuando indicada, una intervención conservadora puede salvar el riñón.

Las técnicas radiológicas especializadas y los métodos urológicos ayudarán al diagnóstico precoz.

Se da cuenta de 5 casos, en mujeres, de duplicación ureteral completa. En uno de los casos aparecían cálculos no obstructores en cada uno de los cuatro uréteres.

1. Drenar siempre el espacio retroperitoneal.
2. Usar siempre suturas reabsorbibles en el tracto urinario.
3. Reparar siempre el tracto urinario sobre un soporte-férula.
4. Dejar siempre derivación urinaria temporal por encima de la lesión ureteral.

Tambien se trata brevemente de la cuestión de urología y embarazo. El tratamiento operatorio necesario no debe ser diferido por la gestación pero siempre que sea posible debe ser conservador.

RÉSUMÉ

Des anomalies urétérales peuvent se produire, adoptant diverses formes curieuses. L'agénésie urétérale bilatérale est extrêmement rare et entraine la mort. Le type unilatéral se rencontre dans environ 2 p. 1000 des naissances. 14 cas seulement d'uretères triples ont été rapportés.

L'uretère double incomplet (uretère en Y) est assez fréquent. Les deux uretères se rejoignent habituellement dans le tiers supérieur, parfois dans let tiers médian, rarement dans le tiers inférieur, pour former un seul uretère débouchant dans la vessie.

La présence de deux orifices urétéraux du même côté ne signifie pas nécessairement un double uretère complet, car il existe des cas d'uretère en Y invertis reliés à un uretère et à un rein unique au-dessus. Cet état s'explique difficilement du point de vue embryologique.

L'uretère double complet se forme dans le foetus à partir de deux bourgeons urétéraux et peut se produire avec un rein double. L'uretère double est considéré comme complet lorsqu'il y a deux orifices urétéraux du même côté. L'uretère principal (à partir du rein le plus bas) se trouve dans la position habituelle sur le trigone, alors que l'uretère secondaire (à partir du rein le plus haut) sort en position médiane et habituellement distale. L'orifice de ce second uretère (à partir du rein le plus haut) est médian et en général distal. Cet orifice secondaire peut s'ouvrir dans la vessie ou la partie postérieure de l'urèthre ou, chez l'homme, dans la vésicule séminale, et, chez la femme, dans le col, l'utérus ou le vagin. Cet orifice urétéral ectopique sera, chez la femme, externe au sphincter, d'où incontinence urinaire.

Le terme de "reduplication" devrait être

réservé aux cas dans lesquels il y a 4 uretères du même côté; on n'en trouve aucun cas dans la littérature.

L'arrière-plan embryologique de l'uretère normal et de l'uretère double est décrit. Aucune théorie n'explique de façon satisfaisante tous les types d'uretères doubles.

Les anomalies du système urinaire prédisposent à la stase urinaire, à l'infection et aux calculs. Le diagnostic d'uretères doubles devrait être précoce, permettant ainsi en cas d'indication une opération conservatrice épargnant le tissu rénal. Il peut être posé avec l'aide de techniques radiologiques et de méthodes urologiques spécialisées.

Cinq cas nouveaux d'uretères doubles complets bilatéraux chez la femme sont décrits. Un cas présentait des calculs (sans obstruction) dans chacun des quatre bassinets.

ZUSAMMENFASSUNG

Anomalien der Harnleiter treten in mannigfachen und seltsamen Formen auf. Beiderseitiges kongenitales Fehlen der Harnleiter ist äusserst selten und immer tödlich. Das Fehlen eines Harnleiters kommt unter tausend Neugeborenen etwa zweimal vor. Verdreifachung eines Ureters ist nur in 14 Fällen berichtet worden.

Die teilweise Verdoppelung eines Harnleiters, der sogenannte "Y-förmige Ureter," ist keine Seltenheit. Die beiden Harnleiter vereinigen sich gewöhnlich im oberen Drittel, gelegentlich im mittleren und selten im unteren Drittel und münden als einzelner Ureter in die Harnblase.

Das Bestehen von zwei Harnleitermündungen auf der gleichen Seite bedeutet nicht notwendigerweise, dass eine Verdoppelung des gesamten Ureters vorliegt; es gibt Berichte über Harnleiter von der Form eines umgekehrten Y, die sich oben zu einem Ureter vereinigen, der in eine einzelne Niere auf dieser Seite einmündet. Embryologisch lässt sich diese Anomalie schwer erklären.

Eine vollständige Verdoppelung eines Harnleiters entwickelt sich aus zwei Ureterensprossen im Fötus und kann mit einer Nierenverdoppelung oder selten mit einer überzähligen Niere einhergehen. Eine Harnleiterverdoppelung wird als vollständig angesehen, wenn auf derselben Seite zwei Harnleitermündungen bestehen. Der grössere (von der unteren Niere abgehende) Harnleiter ist in der gewöhnlichen Lage am Lieutaudschen Dreieck zu finden, während der kleinere (von der oberen Niere stammende) medial und meist distal davon in die Blase einmündet. Die Öffnung des kleineren Ureters kann in die Blase oder in den hinteren Abschnitt der Harnröhre oder (beim Manne) in das Samenbläschen und (bei der Frau) in das Kollum, die Gebärmutterhöhle oder die Scheide führen. Bei der Frau liegt diese ektopische Harnleitermündung ausserhalb des Schliessmuskels, sodass die Patientin eine Harninkontinenz aufweist.

Die Bezeichnung "Wiederverdoppelung" sollte auf Fälle mit vier Harnleitern auf einer Seite beschränkt bleiben, eine Anomalie, über die bisher keine Veröffentlichungen vorliegen.

Die embryologische Entwicklung des normalen und des verdoppelten Harnleiters wird beschrieben. Es gibt bisher keine Theorie, die alle Formen der Harnleiterverdoppelung befriedigend erklärt.

Anomalien des Harnsystems prädisponieren zu Harnstauung, Infektion und Steinerkrankung. Die Diagnose einer Harnleiterverdoppelung sollte frühzeitig gestellt werden, sodass, wenn die Indikation besteht, durch einen konservativen chirurgischen Eingriff Nierengewebe gerettet werden kann. Spezielle röntgenologische und urologische Untersuchungsmethoden verhelfen zur frühen Erkennung der Anomalie.

Es wird über fünf neue Fälle von vollständiger beiderseitiger Harnleiterverdoppelung bei Frauen berichtet. In einem Falle befanden sich nicht verstopfende Steine in jedem der vier intrarenalen Nierenbecken.

RIASSUNTO

Le anomalie dell'uretere sono molteplici. L'agenesia bilaterale è rarissima e incompatibile con la vita; quella unilaterale si manifesta in circa due casi su mille; la triplicazione è rarissima ed è stata descritta in soli 14 casi.

Non rara, invece, è la duplicazione parziale, il cosidetto uretere a Y. I due condotti di solito si riuniscono al terzo superiore, qualche volta al medio e raramente al terzo inferiore.

Il riscontro di due sbocchi dallo stesso lato non significa di necessità che esiste una duplicazione completa; sono stati descritti ureteri a Y rovesciato, difficili da spiegare dal punto di vista embriologico.

La duplicazione completa deriva da un duplice abbozzo fetale e può cosistere con un rene doppio o raramente, con un rene soprannumerario. Essa viene considerata completa quando esistono due sbocchi dallo stesso lato. L'uretere principale (che deriva dal rene inferiore) ha sede normale nel trigono, mentre quello secondario (dal rene superiore) si trova medialmente e di solito distalmente al primo. Quest'ultimo orificio può aprirsi in vescica o nell'uretra posteriore o nelle vescicole seminali o nella cervice, utero, vagina. L'orificio ectopico, nella femmina, rimane all'esterno dello sfintere e pertanto vi è incontinenza.

Il termine di reduplicazione deve essere usato solo in quei casi in cui vi siano 4 ureteri dallo stessi lato, ma questa condizione non è stata fino ad ora descritta.

Viene descritta la genesi embriologica dell'uretere normale e di quello duplicato; nessuna teoria, però, è riuscita a spiegare soddisfacentemente, almeno fino ad ora, tutti i casi di duplicazione ureterale.

Ogni anomalia del tratto urinario predispone alla stasi, all'infezione a alla calcolosi. La diagnosi di duplicazione deve essere fatta precocemente cosi da poter salvare il rene mediante interventi conservativi. Saranno di aiuto le indagini radiologiche e urologiche specialistiche.

Vengono presentati 5 casi di duplicazione ureterale bilaterale completa, occorsi in donne; in una di esse erano presenti calcoli, senza ostruzione, in ciascuna delle 4 pelvi.

SUMARIO

Anômalias ureterais ocorrem em muitas e bizarras formas. Agenesia ureteral bilateral é extremamente rara e incompátivel com a vida. O tipo unilateral ocorre em cerca de dois casos em cada 1000 nascimentos. Triplicação ureteral só foi descrita em 14 casos.

Duplicação ureteral incompleta ou "uréter em Y" não é incomum. Os dois uréteres fundem-se geralmente no terço superior, ocasionalmente no terço médio e raramente no terço inferior, formando um uréter simples que vai ter a bexiga urinária.

Dois orificios ureterais no mesmo lado não significam necessáriamente duplicação uréteral completa, de vez que há casos descritos de "uréter em Y" invertido conectado acima a um simples uréter e rim. Esta condição é dificil de ser explicada embriológicamente.

Duplicação uréteral completa desenvolve-se de dois centros germinais no feto e podem ocorrer com um rim duplo e mais raramente com um rim supernumerário. A duplicação uréteral é considerada completa quando existem dois orificios uréterais no mesmo lado. O uréter maior (do

rim inferior) apresenta-se na sua posição normal no trígono enquanto que o uréter menor desemboca medialmente e mais comumente distalmente. O uréter menor (do rim superior) pode abrir-se na bexiga ou na parte posterior da uretra; ou no homem pode abrir-se nas vesiculas seminais e na mulher no útero cervix ou vagina. Este orifício uréteral ectópico na mulher será externo em relação ao esfincter e a paciente apresentará incontinência urinária.

O termo "reduplicação" deve ser reservado para casos em se encontram quatro uretéres no mesmo lado, condição até agora ainda não descrita na literatura.

Os aspectos embriológicos do uréter normal e duplo são descritos. No presente não há teoria que explique de maneira satisfatória todos os casos de duplicidade uréteral.

Anômalias do tracto urinário predispõe a estase, infecção e cálculos. O diagnóstico de duplicidade uréteral deve ser feito precocemente, tornando possível nos casos em que é indicada cirurgia renal conservadora. Técnicas roentgenológicas especializadas e procedimentos urológicos auxiliarão o diagnóstico precoce.

Cinco casos de duplicação uréteral bilateral completa em pacientes do sexo femenino são apresentados. Em um caso cálculos não obstructivos foram encontrados nas quatro pelvis renais.

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Urinary Stasis, with Emphasis on Stasis Due to Stricture of the Ureter

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VOLUMES have been written on the subject of urinary stasis, and its results and causes are well understood when there is gross obstruction.

When the obstruction is less obvious, however, there is often a lack of real appreciation of the fact that urinary stasis is present and that it is producing the patient's symptoms.

This is the situation when the patient has a slight backache, which is really a pain but is not severe enough to be called a pain; also pain in the loin, or over the small of the back or definite in the costovertebral angle, and also when the pain is only in one of the lower quadrants of the abdomen and does not radiate into the testis or the thigh.

The patient's subjective symptoms, outside the urinary tract, are headache, easy fatigability, lack of appetite, excess gas in the intestine, lack of energy and nervousness.

In numerous cases all these symptoms have existed for years, with patient going from physician to physician and even to a urologist, without a proper diagnosis ever having been made.

Why was no proper diagnosis made? The reason is that, although a good history may have been taken, it was not properly interpreted in the light of the scanty abnormalities observed on physical examination and urologic examination, including cystoscopic retrograde pyelographic study.

On physical examination the only positive sign may be slight tenderness in the costovertebral angle on palpation (bimanual) of the kidneys. Maybe even this is not present; at times the only tenderness that can be elicited is in the lower part of the abdomen, over the course of the ureter. Suprapubic distress and tenderness are often present.

Urinalysis may give entirely negative results and often does. In the early stages the cystoscope may reveal practically nothing except slight trigonitis; perhaps not even trigonitis, but only slight edema and redness of one ureteral orifice.

The retrograde pyelogram may be interpreted as normal when there are no gross abnormalities, especially when only slight delay is revealed in the emptying film taken ten minutes later.

And so in this hypothetical case of minor urologic signs, therefore, it is often inferred that there is nothing wrong with the urinary tract, and the patient is referred to a gastroenterologist, a general surgeon or an orthopedic surgeon, but gets no relief. I have seen this situation so often as to make me most unhappy about the patient's plight.

When I was younger, one of my urologic teachers told my fellow-students and me, "When you do not know what is the matter with the patient, cystoscope him and he will get well." This urologist, a good one of that day, did not know why, but it was in reality the therapeutic test; the passage

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of catheters through the ureters dilated them and relieved the minor but symptom-producing urinary stasis due to stricture of the ureter, which may occur in the intramural portion as it passes through the bladder wall, which is also due to spasm of the ureter, and also often occurs in the intramural portion of that organ. The urinary system is in reality what the "man in the street" calls it, his "water works." As such, it obeys all the laws of hydrodynamics that govern other water systems; the fluid, urine in this instance, accumulates behind a dam or bottleneck due to stricture or spasm, and the pressure occurring above the obstruction is multiplied many times, according to the same principle that obtains in the operation of the hydraulic pump or, if you will, the hydraulic brakes of an automobile.

This back pressure, gradually but incessantly and persistently, dilates the ureter above the obstruction, and the pelvis of the kidney; then the cells of the uriniferous tubules have to secrete urine against this pressure, and so have to do increased work to achieve the same result. This in turn results in the accumulation of more than normal amounts of waste products in the blood stream. These waste products need not be sufficient in amount to be demonstrable on chemical analysis of the blood in order to produce subjective symptoms (fatigue and irritability); in the same way, even small quantities of alcohol in the blood stream change the function of the nervous system, even if only by removing or decreasing one's inhibitions, even slightly.

The thesis of this paper, then, is that one must diagnose urinary stasis which has not been present long enough to produce abnormal blood chemical values or abnormalities visible on the roentgen film and presents only minor cystoscopic indications of trouble.

The condition must be diagnosed on the basis of the history, the results of physical examination (including observation of the Murphy sign by jarring the kidney with a blow over the lower ribs, and so eliciting pain in a great percentage of cases) and the minor cystoscopic signs, and then proved by the therapeutic test of dilation the ureter.

To revert again to roentgen procedures, serial roentgenograms may be used to demonstrate altered ureteral peristalsis.

What happens is that, owing to man's unphysiologic mode of living—too high tension, stress and strain both physical and emotional — a vicious circle is established, which affects all parts of the body and causes malfunction of the autonomic nervous system, which governs the hollow, smooth-muscle organs. Thus the smooth, or nonstriated, muscles of the ureter, etc., go into spasm; this means irritation, which leads to an inflammatory reaction, which in turn produces stricture. One should diagnose very early minor urinary stasis in the same way one should know that the house is on fire before it is a mass of flame; i.e., before there are gross roentgen abnormalities, such as hydronephrosis and stone, which conditions will be prevented altogether by early diagnosis and treatment of the minor stasis.

With this as a preamble and the main point of my paper, let us now inquire more carefully and extensively into the ramifications of this important subject.

The term "urinary stasis" implies the blocking of urine by anything that entirely obstructs, or even only very slightly impedes, its unretarded flow from its site of origin to its exit from the external urinary meatus. This is a broad definition and includes obstruction of individual nephrons occurring, for example. as a result of deposition within the uriniferous tubule of crystals of the various sulfonamides. This will not be considered at present; the discussion will be confined to obstruction in

and below the calyces and to the intramural portion of the ureter.

Site of Obstruction.—The obstruction may be primarily in the calyx, the renal pelvis, the ureteropelvic juncture, the ureter, the ureterovesical juncture, the bladder, the vesicourethral juncture or the urethra.

History.—Obstruction of the upper part of the urinary tract has a long history behind it; stone in the kidney and renal colic are conditions that physicians and surgeons have had to deal with for centuries. It was not till relatively recent times, however, that a true understanding of the actual early underlying pathologic changes was possible. The advent of the roentgen ray, the cystoscope and modern ureteral instruments supplied the means of complete and thorough examination of the urinary tract.

The great gynecologist Howard Kelly postulated stricture of the ureter, but his pupil, Guy Hunner, was the one who really did the pioneer work and established this clinical entity; this he succeeded in doing only after he had faced boldly the skepticism of the profession for years. I myself came in for criticism when I espoused this cause of stricture of the ureter, but much original research on the subject had convinced me of its validity. This entity is not the only cause of such obstruction, but it is the one that often occurs first, and if it is not recognized and successfully treated, which is certainly possible, it brings in its train much suffering and much ill health, and furthermore is extremely often the precursor of more serious conditions, such as of stone and infection.

Etiologic Factors. — A. *Extrinsic Causes; Pressure Due to Tumors, Adhesions and Aberrant Blood Vessels*: 1. A tumor, by its very presence and size, may, if it is in a position to exert pressure on the wall of the ureter, cause urinary stasis, for example, the physiologic tumor of pregnancy.

2. Adhesions will kink the ureter or constrict it, and this, according to Jewett of Johns Hopkins Hospital, occurs in about 5.6 per cent of cases.

3. An aberrant blood vessel may bend or kink the ureter. This happens, according to Jewett, in about 33.8 per cent of cases. A dropped kidney may also cause sufficient bowing of the ureter to cause narrowing of its lumen.

B. *Intrinsic Causes*: These include hyperkeratinization due to lack of vitamin A, stone, tumor, stricture, or spasm. Additionally, an enlarged prostate may so raise the floor of the trigone as to kink the ureter.

Jewett has shown that the stenosis may be congenital, without evidence of inflammatory reaction, at the ureteropelvic juncture, and unassociated with other conditions that might cause obstruction. In his opinion, congenital obstruction occurs in about 40 per cent of cases, inflammatory changes with subepithelial fibrosis occurring in about 20 per cent.

Pathologic Picture. — A questionnaire answered by more than 500 urologists revealed that half of them considered the ureteral fibrosis producing stricture a result of focal infection. Schreiver analyzed 100 consecutive autopsies at the Pathologic Institute of the University of Frankfort and observed 4 cases of definite inflammatory thickening of the ureteral wall causing obstruction and 8 cases of possible congenital thickening. The inflammation was an extension into the ureteral wall of adnexal disease, with or without thrombophlebitis and advanced cystitis. He found little or no evidence to suggest stricture resulting from focal infection. Frater and Braasch examined 93 unselected necropsies and observed no definite strictures but noted that there were small collections of leukocytes in the ureteral

wall. Of these results Moore wrote, in effect, that the lesions resemble the submucous or panmural cystitis of Hunner, a well-known feature of which is extreme sensitiveness, and it was his opinion that they must be regarded as inflammatory. The few specimens that have come to the pathologist show chronic inflammation varying from round cell infiltration, with a small amount of fibrous tissue, to dense fibrosis. The favorite site of the stricture is most often 2 to 6 cm. from the ureteral orifice, in the broad ligament. The next most frequent location is at the bifurcation of the iliac vessels, close to the lymphatic glands.

The results of obstruction can be readily appreciated if one places lightly the tip or palpating surface of the forefinger of the right hand on the dorsum of the soft tissues of the left, which are located between the first and second metacarpal bones. Even very slight pressure causes blanching of the tissues and thus anemia, which, if it occurs in the kidney, may ultimately mean complete destruction thereof.

Symptoms.—Pain: This is a universal symptom and may radiate over an extremely wide area. An older generation of physicians had a clear idea of this, as witness instructions I received from my old teacher of gynecology, who was fond of describing what he called the "genital zone of pain," which he said extended from the umbilicus to the knee. Pain in the upper part of the urinary tract, however, as is now known, may extend even as far as the great toe in a person who is highly sensitive to pain. It may radiate over the precordium and posteriorly, as high as the scapula. The most usual sites of pain are the small of the back, the costovertebral angle and the region along the course of the ureter. Pain often radiates down the thigh, into the testicle and to the tip of the penis. I know and have successfully treated a patient who for many years was unable to stand erect, with both thighs fully extended, without pain; this was the only symptom for some years, and she had learned to stand so that the painful thigh was slightly flexed, which relieved her of pain. The explanation is that the ureter passes over the iliopsoas muscle, which is inserted into the lesser trochanter of the femur and in the erect posture is extended, Thus exerting a pull on the ureter and eliciting pain.

When the pain is referred to the testes, examination more often than not reveals a normal organ, and the pain may be thought to be due to a varicocele.

The actual site of pain at the tip of the penis is about 2 cm. from the meatus and on the undersurface, and often is not more than an itch or an irritation. Examination reveals nothing at this point. The person who knows much about anything is the person who has seen a great deal of it, despite the famous description of a specialist as a person who knows more and more about less and less, till finally he knows all about nothing.

In the days when typhoid fever was rampant everywhere, a Miss Webster, night superintendent of nurses in the Montreal General Hospital, made the observation that one of the very earliest symptoms of perforation of a typhoid ulcer was pain at the end of the penis. Locally, therefore, this symptom was called Miss Webster's sign. At the time there was no appreciation of its real cause, but now it is realized that the peritonitis irritates the immediately underlying ureter, and so pain is reflected to the end of the penis.

So much for symptoms associated with this condition, which may be of any type from a dull ache to excruciating distress.

Vesical Symptoms: These occur sooner or later and in greater or less degree in all or practically all cases, and are the

classic symptoms of frequency and urgency of urination, as well as of hematuria. Frequency occurs, in fact, because an inflamed bladder is most comfortable when it is neither full nor empty. When it is full the distention causes pain, and when it is empty the muscle goes into spasm. Unless there is gross bleeding the hematuria is usually terminal, and is due to the trauma of a violently contracting detrusor muscle on an engorged mucosa.

Posterior Urethritis and Prostatitis: These always result when there is a pathologic condition high in the urinary tract, and of course they are usually nonspecific. The posterior ureteritis, if sufficient, induces a discharge from the penis, and the patient is often treated for chronic prostatitis, as pus is observed in the prostatic secretion.

Fever: This occurs whenever there is sufficient damming back of the flow of urine, with or without infection. If this is the only symptom, as it may be, the patient is often treated for some obscure fever.

Gastrointestinal Symptoms: These are common and vary from aversion to food to vomiting; also, gaseous distention is the rule, and the patient's ureteral colic is often attributed to "gas pains."

Uremic Symptoms: These range from mild to severe.

Examination. — Physical Study: This should always include determination of the blood pressure, as it is now well known that lessening of an effective renal blood flow results often, sooner or later, in cases of hypertension. The Murphy sign, in my estimation, is extremely valuable.

In the female, palpation of the lower end of the ureter while doing a bimanual vaginal examination may reveal a stone in that area. To demonstrate that this palpation is not impossible, D. W. Tovey has recorded the fact that Pawawolick, in 1880, catheterized the ureters by using the ureteral ridges on the anterior vaginal wall as guides. The female urinary meatus may be and often is inflamed and tender. If these conditions exist in sufficient degree the venous congestion will be such that a tumor-like structure, a caruncle, may be seen. Obstruction to the circulation of the anterior female urethra is produced by angulation of the urethra at the triangular ligament, resulting from the so-called pump handle pulling or tugging that takes place when an inflamed trigonal muscle goes into spasm. What confronts one is, in effect, a hemorrhoid at the urinary meatus. The calibre of the urethra, and also the amount of residual urine, should be determined. The testicle is not usually involved, but the epididymis may well be the site of either an acute or a chronic inflammation, which has resulted from infection traveling via the vas deferens and coming from the posterior portion of the urethra when it is infected. Of course, when there is referred pain only, the picture will be normal.

Cystoscopic Study: The results of this may be entirely normal if it is performed under conditions that do not produce traumatic lesions that are taken for preexisting pathologic change. The conventional No. 6 French catheter may go up to the renal pelvis without any undue effort, and yet the ureteral canal may be so reduced as to retard the flow of urine.

Urinalysis: This may give entirely negative results, which, I fear, consigns many patients to a fool's paradise. The patient appreciates the fact that it is more than important for him to have normal urine, and it is a common practice for him to have his urine examined at the neighboring drug store and to come to the wrong conclusion when he hears that the report is normal. The fallacy often leads him to the conclusion, "There is nothing the matter with my urinary tract."

Diagnosis.—The diagnosis can be made successfully only after careful consideration and skillful and informed evaluation of the history of the case, the symptoms presented, and the results of physical, general, urologic, cystoscopic, pyeloureterographic and laboratory examinations.

Treatment. — This should be accomplished by correcting the pathologic condition by cystoscopic surgical intervention and ureteral manipulation or by surgery.

SUMMARY

The author presents a definition of urinary tract obstruction, enumerates the sites of obstruction, gives a brief history stating the development of its true appreciation by the profession, mentions the etiologic factors, the pathologic picture, the results of obstruction, the symptoms, and emphasizes some points in the physical examination of the patient. Further, comments are made on the dystoscopic, pyelographic and pyeloureterographic observations and the laboratory data. He offers a plea not so much for recognition of gross obstructive lesions as for their rational and adequate treatment by means of the more recent refinements of modern surgery and therapeutic technic. Further, a true recording and interpretation of minor symptoms and signs, made possible by all the expert means of investigation now available, will bring about a diagnosis of an obstructive uropathic condition at a time when the obstruction is either mild or has not existed long enough to damage the kidneys greatly. It should be and is possible to make the diagnosis of stasis of the urinary tract in its earliest incipiency.

CONCLUSIONS

Early diagnosis and early effective and usually, or at least often, nonoperative treatment will mean great relief to the patient, will spare to him the all-important renal function and will save him much suffering, even to the extent of rendering unnecessary many of the major operative procedures, and all this because "tall oaks from little acorns grow."

RÉSUMÉ

L'auteur présente une définition de l'obstruction du système urinaire, en mentionne les diverses localisations, les facteurs étiologiques, et décrit le tableau pathologique, les symptômes et l'examen clinique. Il commente les résultats des examens cystoscopiques, pyélographiques et pyélo-urétérographiques et de laboratoire. Une bonne interprétation des symptômes et signes mineurs grâce aux moyens modernes, permet un diagnostic précoce avant l'installation de lésions rénales importantes. Conclusion: un diagnostic précoce permettra souvent un traitement conservateur efficace et évitera en tout cas des opérations importantes, préservant ainsi les fonctions rénales.

RESUMEN

El autor presenta un trabajo sobre las obstrucciones del tracto urinario, enumera los sitios de la obstrucción, incluyendo un resumen de la evolución histórica del conocimiento de la enfermedad y menciona los factores etiológicos, el cuadro patológico, las consecuencias de la obstrucción y los síntomas, dando especial importancia al examen del enfermo. También comenta la observaciones cistoscópicas y pieloureterográficas y los datos del laboratorio.

Defiende no tanto el reconocimiento de las lessiones obstructivas groseras como el tratamiento adecuado con los refinamientos recientes de la cirurgía moderna y de la técnica terapéutica.

Una cuidadosa interpretación de los

pequeños síntomas por los medios de investigación hoy a nuestro alcance puede llevar al conocimiento de obstrucciones en su fase precoz, cuando aún no han dañado de manera importante los riñones.

El diagnóstico de las estasis del tracto urinario puede y debe ser hecho lo antes posible.

CONCLUSIONES

Un diagnóstico precoz y un tratamiento rápido y muchas veces no operatorio proporcionan un gran alivio al enfermo, evitan los trastornos de la importantísima función renal y a veces llevan a hacer innecesarias grandes técnicas quirúrgicas; todo esto porque "de las pequeñas bellotas crecen los robles grandes."

ZUSAMMENFASSUNG

Der Verfasser gibt eine Definition der Verstopfung des Harnsystems, zählt die Lokalisationen der Obstrucktion auf, erwähnt kurz die Geschichte der Entwicklung der richtigen Einschätzung der Erkrankung seitens der Ärzteschaft, führt die ursächlichen Faktoren, das Krankheitsbild, die Folgezustände und Symptome der Harnverstopfung an und hebt einige Punkte in der körperlichen Untersuchung des Kranken hervor. Er geht ferner auf zystoskopische, pyelographische und pyeloureterographische Beobachtungen und auf Laboratoriumsuntersuchungen ein. Das wesentliche Ziel seiner Arbeit ist nicht so sehr auf die Erkennung grober Obstruktionen als auf deren vernünftige und zulängliche Behandlung mittels neuer Verfeinerungen der modernen Chirurgie und der therapeutischen Technik gerichtet. Er hebt ferner hervor, dass eine mit den heute zur Verfügung stehenden speziellen Untersuchungsmethoden mögliche objektive Erfassung und Deutung geringfügiger Symptome und Beschwerden zur Diagnostizierung einer obstruktiven urologischen Erkrankung zu einem Zeitpunkt führen muss, wo die Verstopfung entweder geringgradig oder noch nicht von genügend langer Dauer ist, um die Nieren ernstlich geschädigt zu haben. Es sollte möglich sein und ist in der Tat möglich, eine Stauung im Harnsystem in ihren ersten Anfängen zu erkennen.

SCHLUSSFOLGERUNG

Frühzeitige Diagnose und frühzeitiges Einsetzen einer wirksamen und gewöhnlich oder häufig nicht operativen Behandlung bedeuten für den Kranken grosse Erleichterung seiner Beschwerden, Erhaltung der lebenswichtigen Nierenfunktion und Ersparung vielen Leidens und sogar Vermeidung vieler überflüssiger grosser operativer Eingriffe, und all das weil "grosse Eichen aus kleinen Eicheln wachsen."

SUMÁRIO

O autor apresenta a definição de obstrução do tracto urinário, enumera os pontos de obstrução, menciona brèvemente o evolução e reconhecimento pela profissão, fatores etiológicos, quadro patológico, os resultados da obstrução, os sintômas e põe ênfase em certos pontos do exame físico do paciente.

Além disso, comentários são feitos sôbre as observações cistoscópicas, pielográficas, pielouretérográficas e dados de laboratório,

A atenção e interpretação correta de sinais e sintômas menores possibilitados por todos os métodos de investigação agora oferecidos, proporcionará o diagnóstico de condição uropática obstructiva em uma fase em que a obstrução é ainda moderada e o rim não apresenta grandes danos.

Deve-se é possível fazer o diagnóstico de estase no tracto urinário nas fases mais incipientes.

CONCLUSOES

Diagnóstico precoce e tratamento não cirúrgico precoce, geralmente efectivo, significam muito o paciente pois preservam a de todo importante função renal e poupam muito sofrimento, inclusive grandes operações, e tudo isto porque "de pequenas sementes crescem grandes árvores."

RIASSUNTO

L'Autore definisce le ostruzioni urinarie, ne enumera le sedi possibili, ne racconta brevemente la storia, ne ricorda i fattori etiologici, i quadri anatomici, le conseguenze e i sintomi. Elenca inoltre i quadri cistoscopici, pielografici e pielo-ure terografici relativi e dà importanza non tanto al riconoscimento delle lesioni ostruttivo quanto alla loro cura razionale che si vale dei più recenti progressi della tecnica chirurgica.

Inoltre la raccolta e l'interpretazione accurata dei segni minori resa possibile dai moderni mezzi d'indagine può consentire la diagnosi in una fase in cui l'ostruzione sia ancora di grado modesto o non abbia agito per un tempo sufficientemente lungo da danneggiare il rene.

La diagnosi di stasi urinaria deve e può essere fatta fin dal suo primo inizio.

CONCLUSIONI

Una diagnosi precoce, una cura precoce e possibilmente conservativa significano un grande vantaggio per il paziente, in quanto permettono di salvare la funzione renale, risparmiano molte sofferenze e spesso riescono ad evitare interventi chirurgici di grande portata.

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Claude Bernard—that mighty figure who was not a physiologist but Physiology itself in human form—taught us to think physiologically, to base our opinions not only on experimental data and statistics but also on the normalities and abnormalities of the body processes; Virchow brought this notion down to the level of the cell; Pasteur initiated the "tyranny" of the microbe, which was to last so many years; and Ehrlich and Fleming contributed not only fresh forms of therapy but also fresh approaches to the problem of disease, fresh vantage points from which to track down the sources of disease. But all these men, with the exception of Galen, had one factor in common: They were able *lucidly* and *accurately* to report their observations of the sick human being.

—*Marti-Ibañez*

Some Physical Chemical Properties of Urine in Patients with Calcium-Containing Renal Calculi

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IT is evident that the problem of renal calculus disease is not entirely solved by the spontaneous passage or surgical removal of the stone, as the abnormalities that caused its formation may continue to be present. In renal disease due to stone some derangement of the ordinary urine composition is thought to exist.

The general mechanisms for stone formation in each patient should be determined. This depends largely upon establishing etiologic factors from bacteriologic and chemical studies of urine, chemical studies of blood, roentgen observations and quantitative analysis of the stone, when available.

The quantitative analyses of calculi of the upper part of the urinary tract from more than 450 patients have been tabulated into five groups.[1] The usual ureteral calculus is considered to have formed in the kidney. The four minor groups are those specimens containing respectively magnesium ammonium phosphate, uric acid, cystine and extraneous material. The major group of stones from the classification of quantitative analyses is the group assumed to result from "kidney stone disease." This large group comprises all the stones that are salts of calcium, with either oxalate or phosphate, and in the west Florida "stone belt" it accounts for 80 per cent of all specimens obtained. The great majority of patients with this type of calculus present themselves during the "stone season," May through September, and the calculi generally pass spontaneously or are easily removed cystoscopically. *Quantitative* analyses of these stones have shown several new aspects of the problem. First, oxalate predominates over phosphate in frequency and amount present in the specimens. Second, calculi weighing less than 10 mg. are more frequently oxalate types than is the calcium group generally when size is not considered.

Thus, the ordinary rules of chemical precipitation apply even though oxalate is a relatively minor component of urine. When one considers the high level of phosphate in the urine one would expect high levels of phosphate anions to be present in stone, but this is not the case. In addition, the composition of the stones shows that calcium is the predominant cation. Our statistical compilations reveal that 89 per cent of all specimens contain 15 per cent or more of calcium.

Stones containing over 10 per cent of magnesium ammonium phosphate are typical of high *p*H urine, especially that resulting from urea-splitting infections. This type of stone is seen *relatively* more frequently in geographic areas where renal stones are not as common endogenously as they are in the so-called stone belts. The reason for this is that *relatively* more

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stones result from stasis and infection in the former areas, whereas in the latter areas the factors of heat and dehydration and some possible "x factor" account for a higher proportion of calcium oxalate and calcium phosphate calculi.

In recent years the relation of the calcium level in the urine to calculogenesis has received much attention.[2] Clinical instances of high urine calcium levels lead to stone formation only at times, and stones will often be discovered in patients with urine calcium levels that are normal or lower than normal. The incongruous existence of calcium and phosphates in normal urine is indicative of some other influencing system. It is thought from the chemical evidence at hand that stone formation results to a large extent from some disorder in the normal behavior of calcium.

A possible explanation of the behavior of calcium in the urine can be postulated on the basis of nonionizing calcium compounds. These compounds could be calcium salts, which ionize only slightly, or they could be calcium compounds of the chelate form, heterocycles with polyvalent attachment of calcium. The presence of such compounds in urine has been demonstrated by ion exchange and the dialysis technics.[3]

A relatively simple method was devised for measuring these calcium-binding substances. It is based upon the fact that the addition of calcium chloride solution to urine causes a decrease in the *p*H. This shift in the *p*H can be accounted for by the presence in urine of systems that preferentially hold calcium ions and release hydrogen ions.[4] The equation for this is as follows:

$$\frac{(Ca^{++}}{(2} + {}^{Cl^-}) + \text{H-binding compounds} \rightleftarrows (H^+ + Cl^-) + \frac{Ca^{++}}{2} - \text{binding compounds}$$

The decrease in *p*H means that the binding substances are not fully saturated with calcium and that free calcium ions present in the urine must be in equilibrium with the bound calcium. The magnitude of the *p*H shift with added calcium chloride is from 0.3 to 1.4 units. A note of caution to prevent misunderstanding is that the bound calcium formed during the *p*H decrease is not all in the soluble form. A distinction between soluble and precipitating calcium products has not been made, although it has been observed that urine specimens vary considerably in their ability to hold the added calcium ions in solution.

A titration method to measure the shifting *p*H effect has been devised in an effort to produce a more uniform evaluation of conditions in urine specimens. The method consists of electrometric titration of a slightly acidified urine aliquot with standard alkali. A curve is plotted of the *p*H vs. alkali added. A second aliquot after the addition of neutral calcium chloride is carried through the same procedure. The second curve is plotted next to the first, and then the difference between the two curves is measured in terms of alkali added. The "zeroing" or coinciding point for the two curves is taken at *p*H 5.5, and the calcium binding equivalent or chelation equivalent is taken at *p*H 6.5. Further details have been published elsewhere.[4] Values for calcium-binding capacity are calculated in milliequivalents per twenty-four hour specimen or per liter.

By way of illustration, a set of 4 curve pairs is shown in Figure 1. These are on 4 different specimens. The right-hand curve in each pair is the one obtained with added calcium chloride. The two dotted lines at *p*H 5.5 and at *p*H 6.5 represent the "zeroing position" and the measuring position respectively. The important point demonstrated by these paired curves is

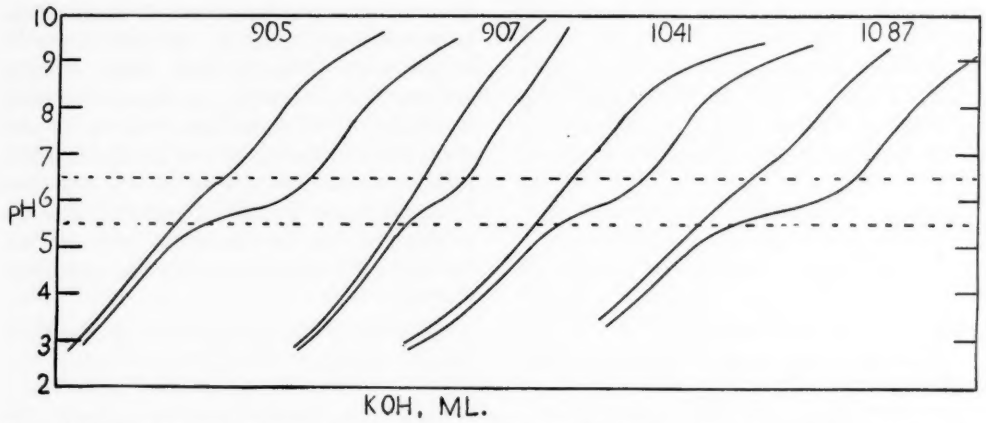

Fig. 1.—Titration curves of four urine specimens; first, of slightly acidified urine, and second, of acidified urine with calcium chloride added.

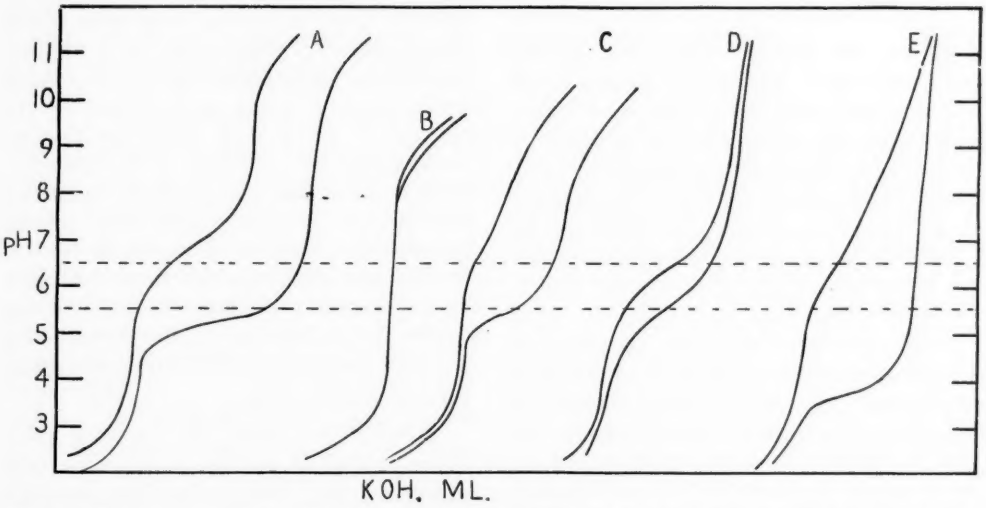

Fig. 2.—Titration curves of phosphate, glycine, glycine-phosphate mixture, glycerophosphate, and phytate; first, of slightly acidified solution, and second, of slightly acidified solution with calcium chloride added.

that the inflection of the calcium chloride curve away from the base curve occurs a little above *p*H 5.5 and that its maximum movement away from the base is very near *p*H 6.5. No exceptions to this have been observed in about 200 different urine specimens.

In order to find an explanation for this behavior, some similar titrations of pure compounds have been made. Five paired curves are shown in Figure 2. The pair marked *A* was obtained by the titration of 88 mg. of monopotassium phosphate with 0.249 N KOH. Although the exact amounts are not necessary for illustration, they are of some help comparatively. Pair

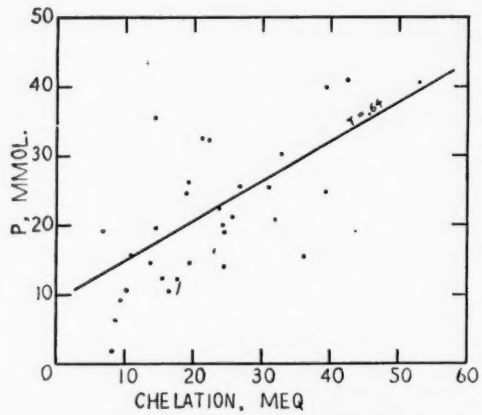

Fig. 3.—Relation of the measured calcium chelation or binding capacity of urine per twenty-four hour specimen to the inorganic phosphorus per twenty-four hour specimen (32 subjects, patients with stone and controls).

A shows the gross configuration of the urine specimens, but the deviation caused by the added calcium chloride takes place at a lower *p*H, about 4.5, rather than at *p*H 5.5 as in urine. The phosphate gives a maximum deviation at about 5.5, a point at which urine shows very little shift. Consequently, if curves are zeroed at *p*H 5.5, then much of the effect of the orthophosphate ion will be nullified.

Curve pair *B* shows the titration of 50 mg. of glycine. Pair *C* is a mixture of 50 mg. of glycine and 44 mg. of KH_2PO_4. Comparative measurement of pair *C* shows that the configuration is closer to the urine specimens. This constitutes our only positive evidence that an amino acid coupled with phosphate may be playing a part in the behavior of calcium ions in urine.

Curve pair *D* was from 102 mg. of sodium-beta-glycerophosphate; *E*, from 250 mg. of sodium phytate USP. Neither *D* nor *E* resembles the urine configurations.

The resemblance in shape, although at different *p*H values, between phosphate and urine prompted the comparison of chelation capacity to phosphorus content. Data were obtained from 32 persons, most of whom were patients with renal calculi. Irrespective of source, the data are shown in Figure 3. The milliequivalents of calcium chelation capacity are plotted against millimoles of phosphorus for twenty-four hour urine specimens. There is a definite relation shown by the curve fitted by the method of least squares with a coefficient of 0.64.

The simple titration scheme devised for measurement of the calcium-binding capacity of urine is measuring some effect of the phosphorus which is present. It is not measuring the phosphate ion alone, because the respective curves are much different as to *p*H value. It is interesting to note that the urine specimens show their greatest binding capacity at or near the normal physiologic *p*H. It is possible that the amino acids, as indicated by the glycine titrations, are changing the behavior of the phosphate toward the behavior of urine. In such a condition fluctuations in either calcium content, phosphate content or amino acid content of the urine could influence the solubility of the stone-forming components in the urine. This concept is not at variance with the rationale of the aluminum gel therapy for phosphatic stones.

Urine from over 40 patients with stone as well as normal persons has been examined for calcium-binding capacity. No definite conclusions can be made, except that the urine of patients with very severe stone formation exhibits very low calcium-binding capacity; 8 of the 10 lowest values were noted in the urine of patients with multiple, bilateral, rapidly growing stones.

The role of calcium-binding capacity in stone formation fits into a scheme best outlined in three stages. The first stage can be called molecular or ionic solutions,

in which there is a mixture of the strongly electrovalent ions, the slightly dissociated organic acids and high molecular weight substances, such as traces of proteins. The second stage includes, in addition, small physical particles within and above the ordinary colloidal dimensions, which have been called microliths. The particles of the second stage may be stabilized by two systems, protective colloids and calcium solubilizing systems. Since microliths can grow by aggregation or by apposition into calculi, which is the third stage, failure of either of the two stabilizing systems results in stone formation. In contrast, there are certain well-known circumstances that frequently lead to calculus formation. Elevated urinary excretion of calcium, phosphorus, cystine and uric acid are able to exceed, in some conditions, the capacities of their stabilizing systems.

SUMMARY

Quantitative analyses of renal stones from 450 patients in the West Florida "stone belt" reveal that 89 per cent contain more than 15 per cent calcium and that 79 per cent are compounds of calcium oxalate and calcium phosphate. Chemical analyses of calcium-containing calculi indicate that it is calcium cation, which is important.

A method is presented for assaying the calcium-binding capacity of urine. From this, curves can be plotted that are characteristic of every urine specimen encountered.

Titrations of mixtures of monopotassium phosphate and glycine will produce curves closely resembling those obtained in urine. From this it is postulated that the great excess of phosphorus in urine may act in part by combining with an amino acid to stabilize the calcium.

RESUMEN

Los análisis cuantitativos de cálculos renales de 450 enfermos del llamado cinturón de piedra ("stone belt") de West Florida demuestran que 98% contienen más de un 15% de calcio y que 79% son compuestos de fosfato cálcico. Los análisis químicos indican la importancia del cation calcio.

Se presenta un método para investigar la capacidad del riñón para la formación de compuestos cálcicos. A partir de dicho método se pueden trazar curvas características de cada muestra de orina estudiada.

Los compuestos de fosfato monopotásico y glicina dan lugar a curvas muy semejantes a las obtenidas con orina. De aquí sacamos la consecuencia de que el gran exceso de fósforo en la orina puede actuar en parte combinádose con los aminoácidos para estabilizar el calcio.

SUMARIO

Análises quantitativas de cálculos renais de 450 pacientes do "cinturão de pedras" no oeste da Flórida, revelou que 89 por cento dos cálculos continham mais de 15 por cento de cálcio e que 79 por cento continham compostos de fosfato de cálcio. Análise química indica que o cation cálcio é o importante.

Um método é apresentado para ensaiar a capacidade de combinação de càlcio da urina, que permite traçar curvas que são caracteristicas de cada amostra de urina encontrada.

Titulação de misturas de fosfato monopotássico e glicina, produzirão curvas bastante semelhantes à aquelas obtidas com urina.

Baseado nisto postula-se que o grande excesso de fósforo na urina pode atuar em parte combinando-se com um amino ácido para estabilizar o cálcio.

ZUSAMMENFASSUNG

Quantitative Analysen von Nierenstei-

nen von 450 Patienten aus der "Harnsteingegend" West-Floridas ergeben, dass 89 Prozent der Steine mehr als 15 Prozent Kalzium enthalten, und dass 79 Prozent Kalziumphosphatverbindungen darstellen. Chemische Untersuchungen weisen darauf hin, dass das Kalziumkation den wichtigen Faktor darstellt.

Es wird ein Verfahren zur Auswertung des Kalziumbindungsvermögens des Harns beschrieben. Auf Grund dieser Untersuchung können Kurven gezeichnet werden, die für jede Urinprobe charakteristisch sind.

Die Titrierung von Mischungen von Monokaliumphosphat und Glykokoll ergeben Kurven, die den vom Urin gewonnenen sehr ähnlich sind. Daraus muss geschlossen werden, dass der grosse Überschuss von Phosphor im Harn durch Kombination mit einer Aminoessigsäure zur Stabilisierung des Kalziums beitragen mag.

RÉSUMÉ

Des analyses quantitatives de calculs rénaux chez 450 malades de la "région des calculs" en Floride occidentale, ont révélé que 89% contiennent plus de 15% de calcium, 79% sont des composés de phosphate de chaux.

Une méthode est présentée pour mesurer la capacité de fixation calcique de l'urine, permettant de tracer des courbes caractéristiques de tous les spécimens d'urine rencontrés.

Les titrations de mélanges de phosphate de monopotassium et de glycine donnent des courbes voisines de celles de l'urine. Il en résulte selon l'auteur, que l'important excédent de phosphore de l'urine peut agir en partie par la combinaison avec un acide aminé pour la stabilisation du calcium.

RIASSUNTO

L'analisi quantitativa della composizione dei calcoli renali di 450 malati dimostrò che 1,89% di essi conteneva più del 15% di calcio e il 79% erano composti di fosfato calcico. Le analisi chimiche dimostrano pertanto l'importanza del catione calcio. Viene quindi descritto un metodo per provare la capacità delle urine di fissare il calcio e per stabilire curve caratteristiche per ogni campione di urine. La titolazione di soluzioni di fosfato monopotassico e di glicina danno delle curve molto simili a quelle ottenute con l'urina.

Da questo fatto si deduce che un eccesso di fosforo nell'urina può agire in combinazione con gli aminoacidi per stabilizzare il calcio.

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Surgical Repair of the Strictured Urethra Not Amenable to Dilation

A New Method

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SINCE the very beginnings of medical therapy, the strictured urethra has been treated by simple dilations. I am in no way attempting to discredit this effective, time-proved method, which suffices to care for more than 90 per cent of patients with urethrel stricture. This still leaves a small number of cases, however, in which some other mode of therapy is required. At this point the methods of treatment become many and diverse, some easy, some complicated. Unfortunately the number of cases in which the average surgeon has to perfect his skill in this area is small, making the more complex procedures too difficult for him to perform with consistent skill. The operation to be described is a simple one, requiring no great special talent or practice.

Although circumstances do not always render it wise or possible, reestablishment of the natural urethral channel is to be desired.[1] Some dense urethral strictures are well handled by internal urethrotomy, but skillful surgeons in this field are passing from us as the incidence of treatable material dwindles. Dense, short strictures of the urethra that close again very rapidly after dilation can be satisfactorily managed by primary resection and anastomosis of the urethra. The method works well if the disease is limited to the bulbomembranous segment and the surrounding perineal structures are not involved in active inflammation or dense fibrosis due to prolonged infection or urinary extravasation. Martin[2] has shown that in some instances a satisfactory anastomosis can be created over a catheter splint, without sutures, to restore satisfactory continuity to the urethra. This principle has been applied successfully to the treatment of some selected urethral strictures.

After the advent of the Denis Browne operation for hypospadias many workers adapted it to the treatment of urethral strictures.[3] These simple, staged procedures are the most gratifying ones known to me, but their usefulness is limited to the pendulous portion of the urethra. When these operations are extended to the bulbomembranous portion, elimination of the stricture is usually incomplete, and if the deep perineal structures are extensively fibrosed it is practically impossible to perform then.

It is for impassable strictures involving all or most of the bulbomembranous portion of the urethra and surrounded by dense, deep perineal fibrosis that a more satisfactory repair has been sought. The Badenoch operation and its variants,[4] in which the entire involved urethra and fibrosed perineal structures are excised *en bloc*, with anastomosis of the distal cut end of the urethra to the vesical neck by means of traction sutures, has various unpleasant sequelae, including deformity of the penis, and impotence and incontinence due to the

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inevitable removal of important functional structures in the radical extirpation. Today there seems little excuse for these procedures except in cases similar to the one sited by Weyrauch,[5] in which the entire perineal structure has been traumatically avulsed. Other operations, employing all sorts of tubular grafts to replace the extensively excised or by-passed urethra, have met with exceedingly variable results,[6] no doubt owing to the varying degrees of avascularity and local infection present in the perineal tissues where the grafts are laid.

The now classic work of D. M. Davis[7] for the treatment of ureteral strictures by partial linear excision with intubation, followed by ureteral regeneration about the tube, led me to explore the feasibility of applying Davis' principle to extensive strictures of the bulbomembranous portion of the urethra. At the time of writing I have applied this principle successfully in 1 case.

Method. — A prior preliminary suprapubic cystostomy was done to resolve infection of the urinary tract and allow the effects of extravasation, fistulization and perineal reaction to subside. When the perineal tissues have gained maximum improvement, the reconstructive operation is commenced.

The patient is placed on the operating table in an exaggerated lithotomy position, prepared and draped as for a perineal prostatic operation. An inverted V incision is made between the ischial tuberosities, with the apex of the V at the perineoscrotal juncture. The scrotum is then retracted anteriorly, somewhat forcefully, and a linear incision is carried forward from the apex of the V, converting it into an inverted Y. This allows adequate exposure without requiring unnecessary undermining of the field. Deep to this skin incision, all the structures overlying the corpus spongiosum urethrae are incised longitudinally over it (many of the structures cannot be identified with anatomic accuracy, owing to perineal fibrosis, but the midline incision prevents any vital damage). Once the corpus spongiosum is gained, the perineal tissues are reflected by sharp knife dissection lateralward to either side of the midline, the entire ventrum of the involved urethra being exposed. *No effort is made to encircle the corpus spongiosum entirely.* It is purposely left attached to its dorsal parietes for preservation of maximum nutrient circulation. Any fistulous tracts are excised. A large sound is then passed through the external urethral meatus to the point of arrest at the distal limit of the stricture. A transverse incision is made about 3 mm. distal to the point of arrest, the tip of the sound being exposed in an area of maximum natural urethral caliber. Another large sound is passed through the cystostomy into the posterior portion of the urethra to the point of perineal arrest. No attempt is made to force it further, and it is held firmly at that point by an assistant. The distal sound is withdrawn, and the proximal cut edge of the corpus spongiosum is grasped in an Allis forceps. With gentle sustained traction on the forceps, the ventral half of the corpus spongiosum and urethra are gradually pared from anterior to posterior until the tip of the proximal sound is reached. The parings are divided transversely at the point of exit of this sound, leaving a roof of urethra and corpus spongiosum. Examination reveals a thin, irregular trench of urethral mucosa in the midline of the pared urethra.

A No. 26 F Foley catheter is then passed through the urethral meatus into the defective area; then it is threaded to the tip of the proximal sound and brought through the cystostomy, where a long, heavy silk suture is tied through the eye of the catheter and is left outside to serve as a pull-through for subsequent catheter

changings if necessary. The catheter is then pulled down against the neck of the bladder with the bag inflated. A cystostomy tube is replaced, and the guide suture is wrapped about it for safekeeping.

The fibromuscular leaves of tissue previously dissected to expose the corpus spongiosum urethrae are then sutured over the catheter with two layers of No. 000 chromic catgut sutures, closely placed. Particular care should be taken in the posterior limits of the closure, as the external urethral sphincter and the urogenital diaphragm may be involved in the scarred tissues. A third layer of loose Lembert sutures is placed superficially to take tension off the deeper sutures. The perineal skin is closed with any suitable nonabsorbable material, and a small rubber dam drain is placed through the posterior extremities of the arms of the inverted Y incision.

Although the wound is left undressed, postoperative care is directed toward cleanliness; particular inspection and cleansing by an attendant after each bowel movement is essential. Cystostomy drainage is continued for four weeks. In the case here reported it was necessary to change the urethral catheter at the third and the fifth postoperative week. This was accomplished easily. Spontaneous, continent voiding is established. After removal of the catheter the urethra is calibrated weekly for one month, after which calibrations are spaced until an interval of three months elapses. Potency is unimpaired. A biopsy specimen taken from the floor of the newly created channel three months after the operation shows complete regeneration of transitional epithelial mucosa, with submucosal glandular structures.

REPORT OF CASE

J.C., a 58-year-old white policeman, was admitted to the Jewish Hospital, Louisville, on July 11, 1956. He stated that in 1944 he had undergone an instrumental operation performed by another urologist (check of the old records revealed this to have been a transurethral resection of the vesical neck for contracture) for slow, difficult voiding. The operation was a complete success for five years. In 1949 the patient noted that the stream of urine was once more becoming progressively more difficult to expel, and by 1955 there was continuous dribbling of urine, for which he wore a rubber urinal. He never returned to his original physician. Three days prior to admission he had noted tender swelling of the scrotum, diminution in the output of urine, chills and fever.

Examination revealed him to be acutely ill. The temperature was 102°; the pulse rate, 104 per minute, and the blood pressure in millimeters of mercury, 110 systolic and 70 diastolic. Pertinent signs were brawny, red edema of the lower part of the abdominal wall, the penis, the scrotum, and the perineum. The scrotum measured 13½ inches (34.2 cm.) in transverse diameter. A urine specimen was not obtainable, and a filiform guide would pass no farther than 3 inches (7.5 cm.) in the urethra. The complete blood count was not remarkable.

The patient was taken to the operating room, where a suprapubic cystostomy was performed. The bladder contained 1,500 cc. of foul, purulent urine. The wall of the bladder was thin, but its internal surface was otherwise normal. An adequate resection of the vesical neck and prostatic urethra had been done by the patient's former surgeon. Neither a sound nor filiform guide could be passed beyond the urogenital diaphragm in an antegrade manner. No attempt was made to reestablish urethral continuity, and the cystostomy was closed about a large mushroom catheter for drainage of the bladder. Through-and-through drainage of the superficial abdominal wall, scrotum and perineum was done. Rapid improvement followed. Follow-up studies of renal function and excretion urograms were surprisingly close to normal. On the eighth postoperative day an attempt was made to pass a filiform guide in the urethra. This failed. A repeated attempt on the seventeenth postoperative day likewise failed, and the patient was sent home with cystostomy drainage, with considerable improvement from the effects of extravasation of urine.

Six weeks after the operation he was readmitted to the hospital. All wounds were healed,

and the tissue reaction from the extravasation of urine had subsided. Again a filiform guide was inserted into the urethra, with arrest as previously described. On August 22 urethroplasty, as previously described, was performed. A benign postoperative course ensued. The patient was discharged on the fourteenth hospital day. The perineal wound was soundly healed, without sinus formation. The cystostomy and the urethral catheters were attached to a glass Y tube and a plastic leg bag, and the patient was instructed in catheter irrigation. The urethral tube was changed at the third and fifth postoperative weeks owing to encrustation. The suprapubic tube had been removed during the fourth postoperative week. During the sixth postoperative week the urethral tube was removed. The suprapubic fistula had closed spontaneously. The patient voided immediately with good control. At the time of writing the urethra has shown no tendency to contraction on subsequent calibrations, and the patient reports good potency. It is necessary to maintain the use of urinary antiseptics continuously to maintain apyuria. Segregated specimens from the kidneys have never been obtained, but it is fair to assume that chronic pyelonephritis exists in a case of this duration.

SUMMARY

The author has sought a satisfactory operation for the relief of impassable stricture of the bulbomembranous urethra, which is quite lengthy and accompanied by extensive sclerosis of the deep perineal structures. The operation described, borrowing the principles advanced in D. M. Davis' operation for ureteral stricture with intubation, produces a patulous urethra lined with transitional epithelium, showing little tendency to contraction. No penile deformity is produced, since there is no shortening of the urethra. Healing takes place without fistula formation. Both potency and continence of urine are preserved.

Although only 1 clinical case is presented, applicable clinical material is difficult to accumulate in quantity in a private practice in these times of vanishing strictures.

SUMARIO

O autor procurou uma operação satisfatória para a cura das estenoses intransponiveis da uretra bulbo-membranosa, acompanhadas de esclerose extensa das estruturas perineais profundas. A operação descrita adopta os principios da operação de D. M. Davis para as estenoses ureterais com intubação, formando uma uretra coberta com epitelio de transição e que apresenta pouca tendência a contração. A operação não produz deformidade peniana de vez que não há encurtamento da uretra. Produz-se cicatrização sem formação de fistula. Tanto a potência como a continência urinaria são preservadas.

ZUSAMMENFASSUNG

Der Verfasser hat sich um die Entwicklung eines befriedigenden Operationsverfahrens zur Behebung undurchgaengiger Strikturen der bulbomembranoesen Harnroehre, die recht langwierig und oft von ausgedehnten sklerotischen Veraenderungen der tiefen Dammgewebe begleitet sind, bemueht.

Das von ihm angegebene Verfahren stuetzt sich auf die von D. M. Davis angegebenen Grundsaetze fuer seine Operation der Harnroehrenstrikturen mit Intubation und schafft eine weit offene mit Uebergangsepithel ausgekleidete Harnroehre, die wenig Neigung zur Kontraktion zeigt. Da es zu keiner Verkuerzung der Harnroehre kommt, entstehen auch keine Deformierungen des Penis. Die Heilung erfolgt ohne Fistelbildung. Sowohl die Potenz als auch die Harnkontrolle bleiben erhalten.

RÉSUMÉ

L'auteur a recherché une opération satisfaisante du rétrécissement de l'urètre bulbomenbraneux accompagné de sclérose périnéale étendue. L'operation décrite est

basée sur les principes de l'opération de D. M. Davis. Elle donne un urètre béant strié d'un épithélium de transition, montrant une faible tendance à la contraction. Il ne se produit aucune déformation du pénis, l'urètre n'étant pas raccourci. La guérison se fait sans fistule, avec conservation de la puissance sexuelle et de la continence urinaire.

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With William Jenner the magic of his surname acted as a spur to fame.

His famous exemplar, Edward Jenner, was a Gloucester village practitioner who discovered vaccination against smallpox, the real beginning of preventive medicine, when he was forty-six years old. Thereafter womankind remained beautiful after the age of twenty-five, for no longer need they carry on their faces the disfiguring memories of smallpox. Edward Jenner was voted thirty thousand pounds by Parliament, and spent the rest of a leisured life interviewing the crowned heads of Europe.

What a model for young *William* Jenner! A man with the same name as his own had conquered the most widespread and terrible of the fevers: but, courage young physician—there are still fevers horrible enough. The London Fever Hospital was full of such cases, dirty, malodorous wretches with every sort of symptom, every kind of rash and eruption on the skin. Even when smallpox was separated, on account of the ease of its diagnosis, there were other feverous maladies in plenty, all with one feature in common, a warmth in the blood which the physician measured by placing the sensitive palm of his hand upon the sick man's overheated brow.

—*Williams*

Neurologic Surgery

Ilioinguinal Neuropathy After Herniorrhaphy

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BASSINI'S operation for inguinal hernia has been a standard success since 1890. Although treatment of the external oblique aponeurosis has been modified, more recently the importance of the transversalis fascia and Cooper's ligament in this operation have been emphasized. The ilioinguinal and iliohypogastric nerves are almost invariably encountered in the course of the dissection during an operation for hernia. Paresthesia and aching pain occasionally follow herniorrhaphy even though repair of the hernia is satisfactory; these symptoms in the groin cause disability. Discomfort may be present at rest, while muscular activity aggravates the distress; the abnormal sensation is regarded as "numbness." Massage of the area may elicit further pain, which is localized just below the subcutaneous inguinal ring. When this symptom is a source of distress to the patient, reoperation is desirable and necessary.

The symptoms are usually due to involvement of the ilioinguinal nerve, which supplies the cutaneous area of the groin. Damage to the iliohypogastric or possibly the genitofemoral nerve may be suspected, because of a possibility of anatomic variation. Operative cure is accomplished by dissection and removal of the ilioinguinal nerve.

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Exploration should be done for possible anatomic variations; if no variation is found, excision of the ilioinguinal nerve should suffice for relief. It may be desirable also to remove the iliohypogastric nerve. When the result is a satisfying relief of symptoms, it proves the somatic origin of the patient's complaints. Prolonged pain, however, may have been neglected. If the condition is neglected too long, personality changes may occur. Emotional changes may develop and have an adverse effect on the patient's marital life. In such a case removal of the nerve may not result in complete cure, and psychiatric or urologic care may be needed. Personality deviations make it less easy for surgical care alone to solve the problem.

REPORT OF CASES

CASE 1.—D. L., a postman, was operated on for hernia acquired by lifting a sack of mail. A year afterward he complained of a persistent ache after a long day of walking his rounds. Massage of the area increased the ache, which was felt by the patient even at rest in bed. At reoperation a thickening of the ilioinguinal nerve was observed, and the nerve was completely removed from near the anterior superior spine down to the subcutaneous inguinal ring. After the operation there was complete relief.

CASE 2.—C. A., a lineman, acquired a hernia at work, which was cured by operation. For a year afterward, persistent pain in the

groin appeared to affect his sexual potency and had an adverse effect on his personality and his marriage. Reoperation, with removal of the ilioinguinal and the iliohypogastric nerve, was followed by improvement.

CASE 3.—P. B., a woman, had had pain in the left groin after an operation for hernia after which the ilioinguinal and iliohypogastric nerves were removed. Three years later she complained of severe pain in the operative region. After complete diagnostic studies showed normal conditions, the wound was revised. Some relief followed. It was noticed, however, that the patient had no further complaints after her divorce was made final and she became selfsupporting.

COMMENT

After herniorrhaphy, disabling postoperative paresthesias may appear without involvement of the nerve in the sutures used to close the oblique aponeurosis. It seems to be associated with a thickened nerve and perineuritis. Neural irritation may result from the manner of the dissection. The rough use of blunt dissection may injure the small blood vessels of the perineurium. Damage to the myelin sheaths may alter the function of nerve fibres and produce causalgia.

The persistent use of sharp dissection results in avoidable inadvertent severance of nerves. Gentle dissection should characterize the purposeful, cautious action of the surgeon. There need be no stubborn adherence to either sharp or blunt dissection. The fragile veins and functioning nerves hidden in fatty and areolar tissue are better disclosed by the gentle brushing of blunt dissection. Fascial planes fused by scarring must be dealt with by anatomic sharp dissection. In general, the dissecting scissors permit both types of dissection, but frequently a clamp-held "peanut" of gauze must be used for the blunt, and the scalpel for sharp, dissection.

CONCLUSION

Perineuritis of the ilioinguinal nerve after herniorrhaphy leads to disabling paresthesia. It may result from rough blunt dissection during an operation. Excision of the nerve in selected cases effectively produces relief.

SCHLUSSFOLGERUNG

Eine im Anschluss an eine Bruchnaht auftretende Perineuritis des Ilioinguinalnerven kann zu lästigen Parästhesien führen. Die Erkrankung mag die Folge grober stumpfer Präparierung während der Operation sein. In ausgewählten Fällen führt die Resektion des Nerven zur Beseitigung der Beschwerden.

CONCLUSIONS

Une périnévrite du nervus ileoinguinalis après herniorrhaphie conduit à la paresthésie avec invalidité. Elle peut provenir d'une dissection brutale durant l'opération. L'excision du nerf dans des cas sélectionnés amène un soulagement.

CONCLUSAO

A perineurite do nervo ileoinguinal apos a herniorafia resulta em parestesia. Pode resultar de dissecção cega durante a operação. A excisão do nervo resolve o problema.

CONCLUSIONI

La perineurite del nervo ileo-inguinale consecutiva a cura di ernia produce una parestesia molto molesta. Può essere causata dalla dissezione intraoperatoria. In qualche caso l'affezione si giova dell'escissione del nervo.

CONCLUSIONES

La perineuritis del nervio ilioinguinal consecutiva a la herniorrafia produce una parestesia muy desagradable. Puede ser consecutiva a la disección tosca y poco delicada durante la operación. En algunos casos se logra el aligio de la molestias con la excisión del nervio.

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Obstetric and Gynecologic Surgery

Toxemia Of Pregnancy

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THE chief symptom of toxemia of pregnancy is a rise in blood pressure. It is sometimes stated in the literature that this form of toxemia may occur without a rise in blood pressure. In my opinion, however, a toxemia in these circumstances may be definitely excluded.

Generally speaking, the course of superimposed toxemia for the mother as well as for the child is less favorable than that of pure toxemia. The therapy of superimposed toxemia is therefore frequently different: thus it is important to be able to differentiate between these two types of toxemia. At first the differential diagnosis appears simple. There exists, however, a considerable group of patients who, judging from the literature, have been forgotten. There is no sharp border between the two major groups. The so-called "forgotten group" consists of women with more or less hypertension. In this group the blood pressure may rise after minimal stress. Many other women undergoing equal stress show normal blood pressure. Many women of the former group become more persistently and severely hypertensive later and are more liable to toxemia during pregnancy.

I regard a relative decrease in the quantity of blood flowing to the placenta as a possible cause of a rise in the blood pressure during pregnancy. Thus the same kind of thing may be thought to occur in a placenta with an inadequate supply of blood as in a kidney through which an insufficient quantity of blood flows. This is the case when the uterus is stretched tightly around its contents, as in primiparae, in multiple pregnancy, in the presence of hydramnios and when the vessels are hypoplastic or sclerotic, preventing adequate dilatation of the vessels. It is clear that the higher the demand of blood for the intervillous spaces, the greater the chance of a shortage and therefore the occurrence of toxemia. This explains the increasing frequency of toxemia with the progress of pregnancy and with the presence of a large placenta, as in cases of hydatiform mole, multiple pregnancy, hydrops fetalis, diabetes (big child and large placenta).

During a pregnancy the vessels dilate. The dilatation which occurs during a first pregnancy does not recede completely. Many investigations have proved that in a healthy multipara the vessels are much wider at the beginning of a pregnancy than are those of a primipara. The only reason for a smaller supply of blood to the placenta in a multipara, therefore, is insufficient elasticity. On this basis I am convinced that toxemia in a multipara must always be considered superimposed. Only when extra factors are present to cause narrowing of the vessels in the uterus, such as a multiple pregnancy, can there be pure toxemia. When, prior to a pregnancy, the vessels are so wide as to guarantee a sufficient supply of blood to the placenta without much vasodilation, toxemia will not occur, in spite of diminished elasticity. This can explain the fact

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that, in about 40 per cent of the total number of pregnancies in women with essential hypertension, no toxicosis occurs. The chance that toxicosis will develop in these women during later pregnancies is small. On the other hand, if toxicosis develops in a multipara, it will probably also develop in her later pregnancies. My experience has shown that this is so, and it must be borne in mind in discussing with a patient the advisability of another pregnancy.

On the basis of the foregoing considerations, I call toxemia superimposed (1) if it occurs during pregnancy in a woman who, prior to the pregnancy, had a blood pressure over 140 systolic and 90 diastolic; (2) if it occurs in a multipara during an otherwise normal pregnancy; (3) if it occurs in a primipara 35 years of age or older, and (4) if it occurs in a pregnancy of less than twenty-eight to thirty weeks' duration.

As I have already said, superimposed toxemia has a poorer prognosis for the mother as well as for the child. There exists for the mother a greater danger of death. This explains, in my opinion, the difference in the mortality rate of eclampsia in women who have had good prenatal care and in those who have not. The vessel walls of the woman with a normal vascular system are very elastic and will constrict quickly in answer to a contraction stimulus. Such toxemia can develop in a very short time and, despite good prenatal care, may be overlooked. Toxemia of pregnancy in a woman with functionally insufficient vessel walls usually occurs early in pregnancy but develops more slowly. There is more chance, then, that this will be discovered, with good prenatal care, before the severe form exists.

In a case of superimposed toxemia there is a greater chance of a residual hypertension or of a higher blood pressure than that which existed before the pregnancy. The majority opinion is that prolonged preeclampsia, albeit pure, often causes chronic hypertension. Without doubt there is a positive relation between the duration of toxemia of pregnancy and the incidence of chronic hypertension following delivery. As I have already stated, toxemia in women with more or less hardened arterioles begins earlier in pregnancy, develops more slowly and lasts longer than does toxemia in a woman with approximately normal vessels (pure toxemia). I am convinced that when toxemia of long duration exists in a woman with normal blood vessels, residual hypertension may occur. When toxemia in a woman with more or less hardened blood vessels is called superimposed, however, pure toxemia of long duration, in my opinion, does not exist. During pregnancy the blood pressure often falls in normotensive as well as in hypertensive women, even to a normal rate. Later in pregnancy it may rise again to the prepregnancy level or higher. Of course, there will be residual hypertension that may give the impression of having persisted after pure toxemia. Chesley shared for years the majority opinion that prolonged preeclampsia often causes chronic hypertension. Recently, however, he has changed his mind. After some extensive research he found that if hypertension continued post partum there was almost always preexistent hypertension. It seems to me that genetic studies might be of some value in determining the relation between inferior vascular systems and in women and the toxemia of pregnancy. It is reasonably sure that hereditary factors play a large role in essential hypertension. In this clinic, Admiral, in order to gain an impression of the frequency with which manifest or latent hypertension exists in association with toxemia of pregnancy, made a detailed study of the blood pres-

sure in the families of the patients. His results show that in approximately 75 per cent the toxemia of pregnancy was superimposed upon an inferior vascular system. One may draw the conclusion that, among women who have toxemia of pregnancy, the number who have poor vascular systems is much larger than the number who have normal ones.

Any decision as to the *method of treatment* to be employed in the gynecologic clinic of the University of Amsterdam is based on the assumption that toxemia of pregnancy is due to an insufficient supply of blood to the placenta. Accordingly, an attempt should be made to increase the blood supply to the placenta, and obviously the administration of substances or the taking of measures that reduce the blood supply to the placenta should be avoided. The insufficient blood supply may possibly reduce the supply of food and oxygen to the fetus resulting in a smaller child or in intrauterine death. Subsequently for the benefit of both mother and child, the administration of estrogen might possibly have a favorable effect. Thus far I have not obtained any positive results with these drugs. I no longer use them.

Lately I have begun to use hypotensive drugs in more and more cases. In my opinion there is a possibility that hypotensive drugs may be useless in those cases in which the blood vessels are hypoplastic to such an extent that even a maximum relaxation of the muscles in the wall will not widen the vessels sufficiently to allow an adequate supply of blood to the placenta. To my mind the same is true of those cases in which the arteriosclerotic changes in the walls of the vessels are so severe that dilation to any pronounced degree is out of the question.

I am convinced, therefore, that the most important indications for the use of hypotensive drugs are as follows:

1. Eclampsia and severe imminent eclampsia: to prevent the outbreak of attacks and to postpone an artificial termination until the child is viable.

2. Severe toxemia early in pregnancy: to increase the duration of the pregnancy so that the child will have a better chance of survival after an artificial termination.

In view of recently acquired knowledge concerning the toxemia of pregnancy, the question must be raised whether pregnancy should not be terminated far more often than it used to be. This applies mainly to women with preexistent vascular disease.

In the interest of the mother and the child, I consider it advisable to consider termination of a pregnancy associated with toxemia in the following circumstances:

1. When the patient is an elderly primipara.

2. When there is pre-existent vascular disease, especially when children have died in previous pregnancies.

3. When the toxemia started early in pregnancy.

4. When the condition fails to improve or perhaps even becomes aggravated in spite of correctly employed conservative treatment.

5. When the blood pressure is very high, particularly when it is still rising.

As experience has shown that the prognosis for the infant is poor when it is born before the thirty-fourth week of pregnancy, termination of pregnancy is postponed until some time after that week, if possible. It is done earlier only in case of emergency.

What methods should be used in terminating pregnancy? Various authors consider continuous intravenous administration of pitocin the best method. Should the toxemia be due to an insufficient supply of blood to the placenta, this method

involves considerable hazards. The contractions will reduce the blood supply to an even greater extent, especially when the contractions are more or less tetanic. Abdominal cesarean section, therefore, is often preferred in this clinic.

In recent years the maternal mortality rate in the gynecologic clinic of the University of Amsterdam has shown a marked decline.

Of the women who were given prenatal care in the clinic, not a single one has died from eclampsia since I became head of the department (1938). The mortality rate for all women with eclampsia hospitalized in the clinic, which includes those who were given prenatal care here as well as those given prenatal care in other hospitals, was 8.1 per cent (7 of 86) from 1938 to 1944 inclusive, and 4.2 per cent (4 of 95) from 1945 to 1955 inclusive. After 1952 the maternal mortality rate for 19 patients was nil. The perinatal mortality rate was 35 per cent and 27 per cent respectively. Between 1947 and July 1, 1957, there were 163 patients with imminent eclampsia, of whom 2 died. The perinatal mortality rate of imminent eclampsia was 31.6 per cent from 1938 to 1946 inclusive, 23 per cent from 1947 to 1950 inclusive and 17 per cent from 1951 to 1955 inclusive. From July 1, 1956, to July 1, 1957, the perinatal mortality rate was 16 per cent (5 in 32, or 15.6 per cent).

The perinatal mortality rate in the booked cases for the period 1947-1950 inclusive was 5 in 36, or 14 per cent, in the period 1951-1955 inclusive, 2 in 46, or 4.5 per cent, and in the period from July 1, 1956, to July 1, 1957, 3 in 12, or 25 per cent. Thus the maternal and the perinatal mortality rate in booked cases, i.e., in patients with good prenatal care, is much lower than in patients with insufficient control. The fetal mortality rate comprises all children, including infants and those who had already died.

As has been stated, in recent years abdominal cesarean section has been increasingly performed in cases of imminent eclampsia. From 1947 to 1955 inclusive, in 27 cases in which abdominal ceserean section was performed for imminent eclampsia, there were no maternal deaths and 2 children died.

I consider the improved results obtained in recent years to be due to frequent use of active methods of treatment. In addition, family physicians and midwives may have promoted the decline in mortality. Maternal mortality throughout the Netherlands has also shown a definite decline.

The therapeutic importance of knowing the cause, i.e., the insufficient blood supply to the placenta, is shown in the following case:

A 22-year-old primipara with contracted kidneys was admitted to the clinic.

She was given complete bedrest and a low salt and low protein diet. (The diet was not salt *free*, in view of the severely impaired renal function.)

During pregnancy the blood pressure in millimeters of mercury continued at the same level: 140 systolic and 90 diastolic. Nor did the albuminuria increase: Esbach, ½ to 1-0/00. The urea clearance varied from 8 to 22 per cent.

Occasionally the concentration of urea showed an increase. The patient was given an alternating protein-free diet after Borst, and a marked increase in the concentration of urea was prevented. The size of the child was estimated in accordance with the duration of pregnancy.

As the blood pressure did not rise, the albuminuria did not increase (which suggests the absence of any increasing spasm of the renal arterioles) and the weight of the child seemed normal, it was concluded that there was no toxemia and therefore no danger to the child. Danger to the

mother was to be feared only to the extent that pregnancy had resulted in an increased metabolic rate. This was reduced again by complete bedrest. Accordingly, it was decided to allow pregnancy to proceed under rigid control. A viable child weighing 3,150 Gm. was born spontaneously at term. Post partum the blood pressure gradually rose to 180 systolic and 120 diastolic. This might be regarded as evidence that the pregnancy had caused damage after all. In my opinion, however, it is not unlikely that the blood pressure remained low during the pregnancy as a result of the action of hormones produced by the placenta and that there would have been an earlier rise in blood pressure if the woman had not been pregnant. I ventured to allow pregnancy to proceed, since theoretical arguments based on my view of the cause led me to conclude that there was no danger in doing so.

SUMMARY

Emphasizing the point that the first symptom of the toxemia of pregnancy is increased blood pressure, the author discusses "superimposed" toxemia, which offers a poorer prognosis for both mother and child than does the ordinary type. He considers the toxemia "superimposed" (a) when it occurs during pregnancy in a woman who, prior to the pregnancy, had a blood pressure above 140 mm. of mercury systolic and 90 mm. diastolic; (b) when it occurs in a multipara during an otherwise normal pregnancy; (c) when it occurs in a primipara 35 years of age or older, and (4) when it occurs in a pregnancy of less than twenty-eight or thirty weeks' duration. The use of hypotensive drugs and, in certain instances, the termination of pregnancy are discussed.

RESUMEN

Llamando la atención sobre el hecho de que el primer síntoma de la toxemia del embarazo es la elevación de la presión sanguínea, el autor se ocupa de la toxemia "sobreañadida," que representa un peor pronóstico para la madre y para el niño que la de tipo corriente.

El autor considera la toxemia como "sobreañadida": (a) cuando ocurre durante el embarazo en una mujer que antes del mismo tenía una presión más alta de 90-140 mm. de mercurio; (b) cuando ocurre en una multípara durante un embarazo normal; (c) cuando se presenta en una mulípara de 35 años o más; (d) cuando aparece en un embarazo dentro de las primeras 30 semanas. Termina el autor su trabajo considerando el empleo de los medicamentos hipotensores y eventualmente la interrupción del embarazo.

RIASSUNTO

Ricordando che il primo segno della tossiemia in gravidanza è rappresentato dall'aumento della pressione arteriosa, l'Autore tratta della tossiemia "sovrapposta" la cui prognosi è ancora peggiore tanto per la madre come per il figlio.

Egli considera la tossiemia come "sovrapposta": 1) quando si verifica durante la gravidanza in una donna che, antecedentemente, avesse una pressione di oltre 140/90; 2) quando si verifica in una multipara durante una gravidanza altrimenti normale; 3) quandó si verifica in una primipara di oltre 35 anni; 4) quando si verifica in una gravidanza di meno di 28-30 settimane.

Viene discusso l'impiego dei farmaci ipotensivi e la eventuale interruzione.

ZUSAMMENFASSUNG

Unter Hervorhebung der Tatsache, dass das erste Symptom der Schwangerschaftstoxikose die Blutdruckserhöhung ist, erörtert der Verfasser die "aufgepfropfte" Toxikämie, die für Mutter und Kind eine

schlechtere Prognose abgibt als die gewöhnliche Form. Er betrachtet die Toxikämie als "aufgepropft": a) wenn sie während der Schwangerschaft bei einer Frau auftritt, die vor der Schwangerschaft einen Blutdruck von mehr als 140/90 mm Hg hatte, b) wenn sie bei einer Mehrgebärenden während einer sonst normalen Schwangerschaft auftritt, c) wenn sie bei einer Erstgebärenden im Alter von 35 oder mehr Jahren auftritt, und d) wenn sie in einer Schwangerschaft von weniger als 28 oder 30 Wochen Dauer auftritt. Die Verwendung blutdrucksenkender Arzneimittel und die unter gewissen Umständen erforderliche Unterbrechung der Schwangerschaft werden erörtert.

RÉSUMÉ

Le premier symptôme de la toxémie de la grossesse est l'hypertension. L'auteur analyse la toxémie "superposée" dont le pronostic est plus grave que celui de la toxémie simple, aussi bien pour la mère que pour l'enfant. Selon lui il y a toxémie "superposée" dans les cas suivants: a) lorsqu'elle se produit durant la grassesse chez une femme dont la pression était, avant la grossesse, supérieure à 14/9 cm hg; b) lorsqu'elle apparaît chez une primipare de 35 ans ou plus; c) lorsqu'elle apparaît chez une multipare durant une grossesse par ailleurs normale; d) lorsqu'elle se manifeste au cours d'une grossesse de 28 à 30 semaines.

L'administration d'hypotenseurs et, dans certains cas, l'interruption de la grossesse sont discutés.

SUMARIO

Fazendo ênfase no ponto de que o aumento da pressão arterial é o primeiro sintóma da toxemia gravídica, o autor discute a toxemia superimposta que oferece um prognóstico mais sombrio tanto para a mãe como a criança, que nos casos comuns. Considera como toxemia superimposta quando; a) quando ocorre durante a gravidez em uma mulher que antes da concepção apresentava uma pressão arterial acima de 140 mm. de mercúrio sistólica e 90 mm. de mercúrio diastólica. b) Quando ocorre em multípara durante gravidez aparentemente normal; c) quando aparece em mulher primípara de 35 ou mais anos de idade e d) quando ocorre durante uma gravidez de duração menor que 28 ou 30 semanas.

O uso de drogas hipotensivas, em certas instâncias o término da gravidez são discutidas.

It is not too much to say that perfect health is impossible without a perfect abdominal wall. Yet when its youthful curves disappear in middle-aged spread, how many of us regret more than the passing of our figures, or realize that the lassitude, the disinclination for exertion, and the mental complacency which appear at the same time, are all symptoms of insufficiency in the tone of this all important sheet of muscle.

—Ogilvie

Certain Recent Trends in Surgical Treatment of the Eyes*

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IT has been said disparagingly that whenever an ophthalmologist has insomnia he devises a new operation. We should be grateful to our sleepless colleagues who have contributed so much to the advancement of ophthalmic surgery and by this to the prevention of blindness.

Owing to the increasing age of our population, the surgical treatment of cataract and the management of its complications are becoming even more important; therefore this subject will be discussed first.

Certain Trends in the Surgical Treatment of Cataract.—The battle over the limbus-based versus the fornix-based flap is still unresolved. It is our firm conviction that limbal based flaps, if the conjunctival incision is kept away from the wound, are safer, especially in preventing epithelial downgrowth.

Most ophthalmic surgeons now agree, in spite of early opposition,[1] that sutures are highly desirable, only as many being used as are needed to close the wound. Sutures produce a certain amount of degeneration of the tissues, and this may lead to epithelial downgrowth along the suture track, especially when silk sutures are used. There is a trend toward using mild chromic catgut instead of silk sutures, especially since excellent atraumatic needles have been made available. It is unnecessary, although desirable, to remove unabsorbed sutures. Recently Barraquer[2] and other surgeons have placed the sutures subconjunctivally, leaving them there.

There is a tendency toward preplaced sutures, and many surgeons have discarded the use of methylene blue or other stains in making visible suture tracks. We find a stained track valuable, however, especially in making corneal incisions after filtering operations for glaucoma. The incision is made with a special narrow cataract knife with straight back, through the stained tracks (Fig. 1*A*) anterior to the filtering wound instead of below[3] or laterally.[4]

In ordinary cataract extraction we prefer placing three mattress (mild chromic catgut) sutures horizontally as close to the flap as possible (Fig. 2*B*), lightly cauterizing the sclera around the upper half of the cornea to minimize bleeding, and making partial *scleral* incisions with a keratome-like knife and a central small keratome incision (Fig. 1*C*). After the sutures have been placed through both lips of the central scleral wound, the cataract section is enlarged with scissors (Fig. 1*D*) and the lateral sutures completed. After iridotomy or iridectomy, the lens is extracted and the central and the two lateral

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mattress sutures are tied under the conjunctival flap. A centrally locked suture of No. 5-0 plain catgut closes the conjunctival wound.

With careful suturing of the type suggested, the anterior chamber is almost always restored before the patient leaves the table, and air need not be employed unless the anterior chamber remains shallow, or in cases in which the vitreous bulges far forward. Lassiter[5] recommended posterior sclerotomy and air injection in the treatment of late persistent collapse of the anterior chamber following cataract extraction. Thorpe[6] and Burch[7] found diamox useful in the management of nonleaking flat anterior chambers. A total dose of 1,000 mg. of diamox orally per day is effective in most cases, and if the anterior chamber does not reform, Thorpe recommends the continuance of diamox for four to five days. In persistently flat chambers we have trephined the sclera over the pars plana after the application of diathermy, permitted vitreous to escape, separated the anterior synechia and injected air into the anterior chamber with some success.

There is a trend toward more round pupils with one, two or three peripheral iridotomies; we prefer two. Radial iridotomy is performed when the pupil is rigid; a complete basal iridectomy is made where there has been inflammation and where

TABLE 1.—*Results of Surgical Treatment of the Superior Oblique Muscles*
Amount of Correction in Prism Diopters Obtained at Operation on the Superior Obliques

No. of Cases	Retroplacement or Recession, Mm.	Tucking	Combined Operation	Prism Diopters Corrected in Primary Position 6 M.		Field of Action —25 Cm.	Fusion	Duration of Observance
1	7		Resection LLR	10Δ	10Δ	10Δ	3d	18 months
1	6		Resection LLR; previous operation, and retroplacement RLR & LLR., resection RMR & LIR	3Δ	3▲	Not recorded	2d & 3d	1 year
1 (Traumatic muscle paresis O.S.)	5		Resection LIR (previous operation on LIR & LSR)	2Δ	2Δ	4Δ	Spotty	1 year
1	2	8 (16 mm. effect)	Retroplacement RIO 10 mm. & retroplacement RLR	25Δ	25Δ		2d & 3d (reading improved)	1 month
1		9 mm.	Retroplacement RIO	10▲	10Δ		With head tilted	
6 mo. after operation, patient had increased vertical of 4▲ for distance and rear vision								
1		10 mm. bilateral	Retroplacement LMR and RIO; stretching RMR later; retroplacement LIO; Myotomy RIO, retroplacement RMR	R-6 L-12	R-6 L-2		Not described; Good cosmetic appearance	

One patient (female) with cicatrical exotropia, left hypertropia (actually right hypotropia) after operation in 1927 (Type ?). Adhesion of RMR and RLR freed and resection RMR done. Later, RIO resected followed by myectomy of RSO and retroplacement of LIO and LMR. Evaluation of individual operation difficult but overall result excellent cosmetically. Approximately ½Δ correction per mm. surgery obtained for distance and 1½▲ per mm. surgery for near. Patient claims momentary fusion at times.

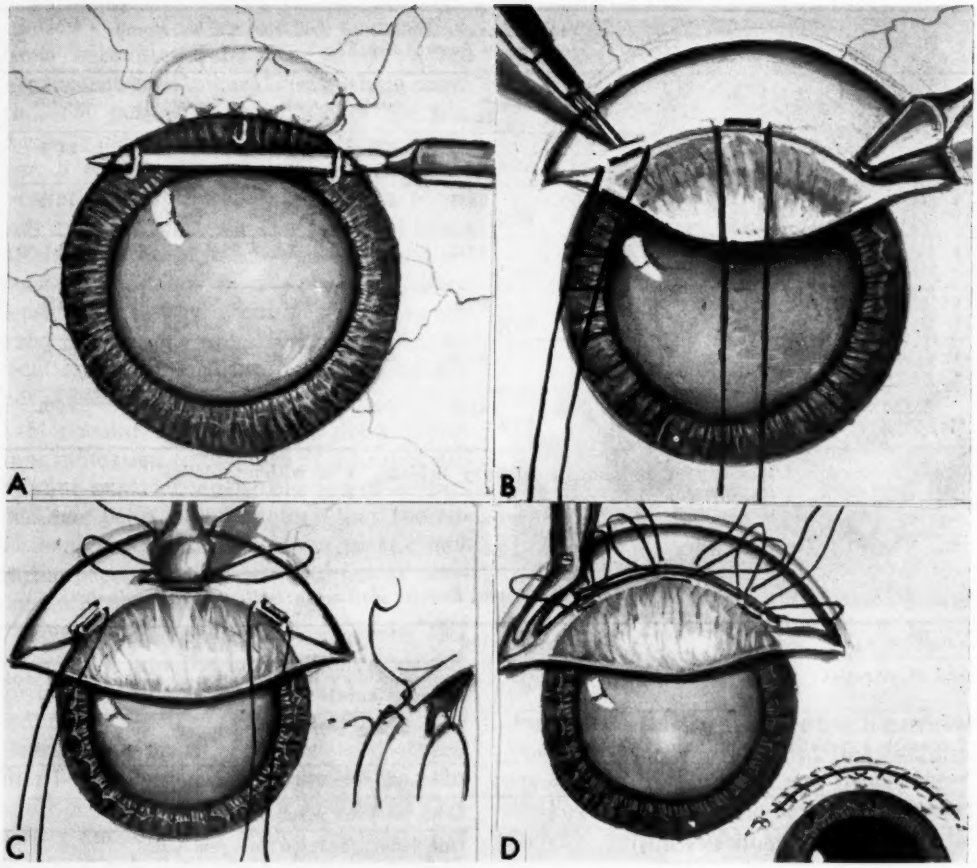

Fig. 1.—*A*, cataract extraction after filterating operations for glaucoma. Incision is made with narrow, straight-backed cataract knife, through stained tracks anterior to filtering wound. *B*, ordinary cataract extraction, in which three mild chromic catgut sutures are inserted horizontally as close to flap as possible. Bleeding is minimized with light cautery, and partial scleral incisions are made with a keratome-like knife. *C*, small central keratome incision made and sutures passed through both lips of central scleral wound. *D*, cataract section enlarged with scissors; lateral sutures completed. Iridotomy or iridectomy is performed, lens extracted and sutures tied under conjunctival flap. Conjunctiva is closed with centrally locked running suture.

glaucoma already exists or is feared.

Intraocular Lenticular Substitutes. — Ridley and Strampelli Lens Implants: In 1954, Finley and Romaine[8] reported the results in nine eyes from the Berens service at the New York Eye and Ear Infirmary, in which the Ridley lens[9] was inserted after cataract extraction. Two of these operations were performed by Ridley personally. The authors reported visual improvement of 20/40 or better in four eyes; 2 of these had good fusion. After a lengthier postoperative observation, however, we have noted that only 2 of these patients retained 20/40 vision; in the other two cases, vision was reduced to 20/50-1 and 20/70. In the earlier report, 2 of the lenses were removed because of severe iritis and glaucoma; 1 of these was in a questionable case of sym-

TABLE 2.—*Statistical Postoperative Results Following Iridocorneosclerectomy Observed for One to Twenty-five Years*

A) Type of Glaucoma B) Primary Procedure	No. of Eyes	Tension Controlled+ 1—	2—	Hypotonic	Enuc. or Evis.	Vision++) 1—	2—	Additional Operation
A) Chronic simple B) 91%	386	31%	49% 80%	1%	3%	39%	11% 50%	14%
A) Acute B) 94%	73	33%	34% 67%	7%	8%	49%	43% 92%	16%
A) Aphakia B) 99%	24	18+%	42% 58+%	4%	21%	31%	5% 36%	31+%
A) Uveitis-secondary B) 91%	24	38%	46% 84%	0	4%	65%	9% 74%	18%
A) Absolute B) 25%	4	0	50%	0	25%			33%
Total (Mean Percentage)	511	30%	47% 77%	2%	4%	40%	16% 56%	16%

\+ Tension controlled under 25 mm. of mercury Schiotz 1 = without miotics
++ Vision 1 = Improved 2 = with miotics
2 = Unchanged

TABLE 3.—*Complications and Results Following Ridley Lens Implants**

Complications	*No. of Eyes*	*Results*
Loss of vitreous	2	Use of Ridley lens abandoned at operation (not included here)
Severe iritis and glaucoma (1 case of possible sympathetic ophthalmitis)	2	Both lenses removed postoperatively
Secondary glaucoma	3	One lens removed postoperatively
Chronic uveitis	1	Lens removed after 3 years
Occluded pupil (1 with iridocyclitis)	3	One lens scheduled for removal Postoperative vision reduced in 1 case from 20/40 to 20/70
Protracted convalesence	Most cases	

*Clinic cases, New York Eye and Ear Infirmary, observed up to 3 years.

pathetic ophthalmitis. Two additional lenses have since been removed, 1 because of painful chronic uveitis of three years' duration, and the other because of secondary glaucoma, making a total of 44+ per cent of the lenses removed. In another patient the removal of the Ridley lens was scheduled, but the patient failed to return.

The results and postoperative complications of this small series of cases as shown in Table 3 indicate that the hazards involved in inserting the Ridley lens in the posterior chamber does not seem to justify the use of this procedure, at least with the technic and lenses we employed. On the other hand, encouraging results have been reported by Reese and Hamdi,[10] who have inserted Ridley lenses into 115 eyes, observed over a period of five years. The authors admit they have had more success with this operation than others and attribute this to more experience with a greater number of cases, careful selection of patients, technic and diligent postop-

erative care. The postoperative complications encountered in this series of 115 eyes were: striate keratitis of short duration (30 per cent); prolapse of the iris, 4 cases; hemorrhage in the anterior chamber, 5 cases; glaucoma, 5 per cent (not present in the other eye); exudative pupillary membrane, 5 per cent; phakodonesis of short duration in several eyes; and recurrence of flare in 23 per cent. Four lenses were removed, but all these eyes had good vision with aphakic correction. Dislocation of the lens into the vitreous was not observed.

Monocular cataract is the most important indication for the use of a Ridley lens but our experience with the use of contact lens has been so satisfactory that the additional risk of implanting a plastic lens in the posterior chamber does not at present seem warranted.

Strampelli[11] introduced an acrylic lens (Fig. 2*A*) into the anterior chamber following cataract extraction and this procedure has received favorable reports from Barraquer Moner,[12] Salleras[13] and others. Bietti[14] has implanted 15 lenses into the anterior chamber with one bad result (keratitis and opacity) which he attributes to reaction to the plastic lens. The lenses are more easily introduced than the Ridley implant with fewer complications and so far apparently with superior postoperative results. Salleras[13] modified the Strampelli lens with four points of support (Fig. 2*B*) in order to avoid its rotation in the anterior chamber.

One of us (C. B.) implanted a Strampelli plastic lens (+16) into the anterior chamber of a patient aged 52, who had undergone a cataract extraction in 1952. A secondary membrane, iris bombé and bullous keratitis developed after the cataract extraction, in which the lens nucleus had been left. Transfixations of the iris, iridocapsulotomy, a lamellar transplant and two penetrating transplants were performed on this eye over a period of two years with no improvement in visual acuity (light perception) and in extremely shallow anterior chamber. The iris and capsule were attached to the center of the cornea and graft. For four months after the Strampelli lens implant and another iridocapsulotomy and penetrating corneal graft, the patient was able to read 600 mm. print with a Policoff lens +5 and 500 mm. print with a Policoff lens +20. The lens had become incapsulated and displaced laterally but prevented anterior synechiae from forming. Eight months after the operation, however, the cornea became opaque and vision was reduced to hand movement.

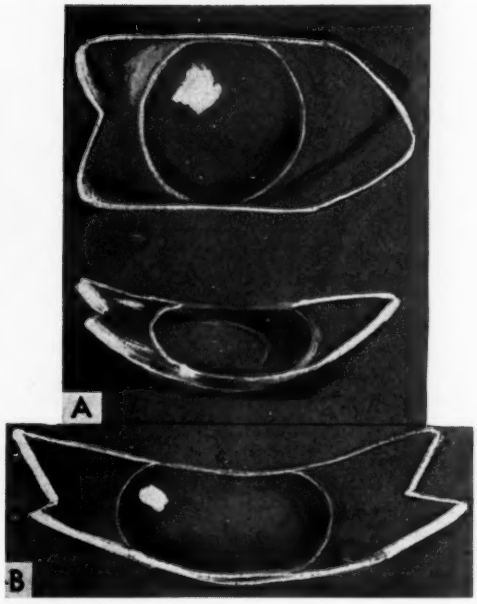

Fig. 2.—*A*, strampelli acrylic lens. *B*, Salleras modification of Strampelli plastic lens.

Technic of Inclusion of Strampelli or Salleras Lens in the Anterior Chamber: A conjunctival flap is fashioned approximately 5 mm. from the corneal limbus, extending from about 2 to 4 o'clock. A keratome incision is made into the anterior

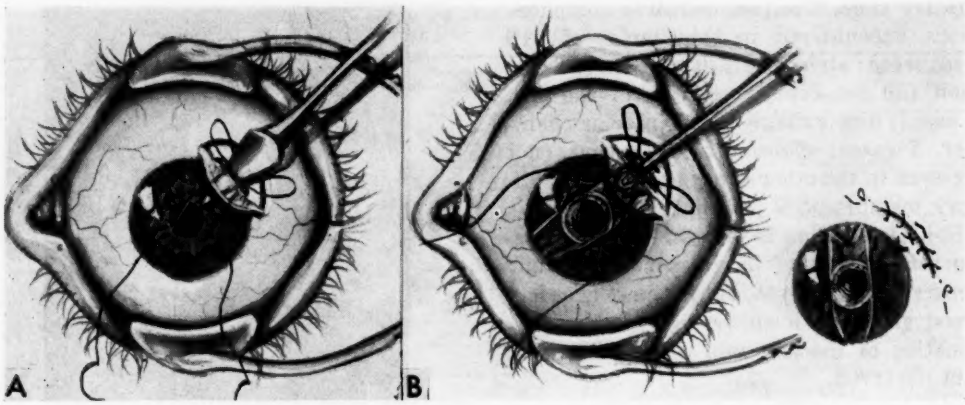

Fig. 3.—*A*, introduction of plastic lens into the anterior chamber. Conjunctival flap is formed 5 mm. from the limbus, from 2 to 4 o'clock. Keratome incision is made close to limbus and double-armed suture inserted through lips of scleral wound. *B*, Strampelli or Salleras lens introduced horizontally across the anterior chamber and rotated vertically with duck-billed forceps. Suture is tied and conjunctival wound united with running centrally locked suture.

chamber, close to the corneal limbus, and a double-armed suture is inserted through the scleral lips of the wound (Fig. 3*A*). The lens is inserted with duck-bill forceps through the scleral incision and passed horizontally across the anterior chamber. The lens is rotated into the vertical position (Fig. 3*B*). The mattress suture is tied and the conjunctival wound is sutured. Barraquer-Moner[14a] recommends a peripheral iridectomy to prevent a pupillary block glaucoma.

Trends in Surgical Treatment of Retinal Detachment.—In the United States there is a trend toward a return to the use of indirect ophthalmoscopic study in diagnosis, stimulated by Schepens'[15] ophthalmoscope, with stereoscopic visualization and scleral depression as important aids in localizing retinal tears. The improvement in the illumination of the American Optical Company instrument, the Keeler pantoscope and Zeiss ophthalmoscopes has made the employment of this method more useful.

Diathermy seems to be the method of choice for producing adhesions between the choroid and the retina, and some still use catholysis for patients with rather flat detachments. We employ electrolysis in some cases, especially for interior flat detachments, because of its better controllability and its effectiveness even in a wet field. Electrolysis is used by Goldmann[16] for treating macular tears, with a long electrode passed into the vitreous under direct observation with the biomicroscope through a contact lens. Goldmann's method may be applicable where the light coagulation of Meyer-Schwickerath[17] is inapplicable. Better methods of gauging the temperature of diathermy are still needed. Weekers used a Pyrometer[18] when employing diathermy in glaucoma, but has discarded it. Most ophthalmologists consider it impossible to gauge diathermy accurately because of the varying resistance of tissues to the current.

The study of undesirable scleral damage from diathermy is being undertaken by various investigators, notably by McLean.[19]

The use of pins is often indicated, and the new and flatter round-headed pins*

*Made by Storz Instrument Company, St. Louis, Missouri.

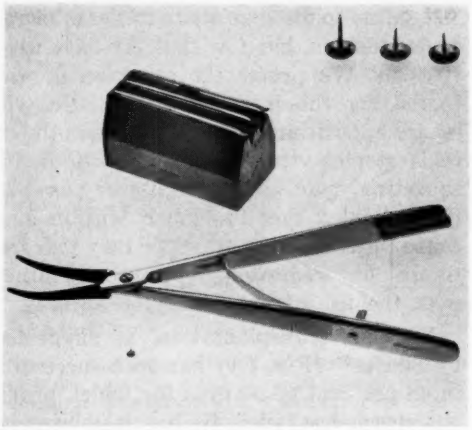

Fig. 4.—Round-headed pins and special forceps for surgical detachment of retina (Berens).

and special forceps (Fig. 4) have minimized the tendency for the pins to become displaced prematurely. The subretinal fluid, if present on the sclera, complicates the further use of diathermy, so that nonpenetrating diathermy applications should be made before the sclera is perforated or pins are applied.

Scleral Resection—Total and Lamellar —and Scleral Buckling.—Total scleral resection was first proposed by Müller in 1903, but lamellar resection seems to have been first performed by Cornet,[20] and is usually employed today, generally combined with buckling of the sclera inward by direct suturing or with polyethylene tubing[21] or with an outward buckling using direct sutures or the Castroviejo monel clips.[22] Custodis[23] produces an indentation of the sclera overlying the retinal break, using a cylindric piece of "poliviol" (polymerized alcohol of elastic, rubber-like consistency and chemically inert to the tissue), held by strong intrascleral "supramid" sutures. The poliviol cylinder is left in place indefinitely or is removed in from two to six weeks if the surgeon deems it desirable, or in case of undue eye irritation. Custodis performed 340 operations by this method and claimed that his procedure considerably shortens the average period of hospitalization and that no preoperative bed rest is ordered to flatten high detachments. As soon as the retina is found to be attached to the protruding choroid, the patient is out of bed, with stenopeic glasses in uncomplicated cases (two to three days; five to eight days in complicated cases).

The Schepens technic consists of excising a lamellar strip of sclera and applying multiple surface diathermy coagulations

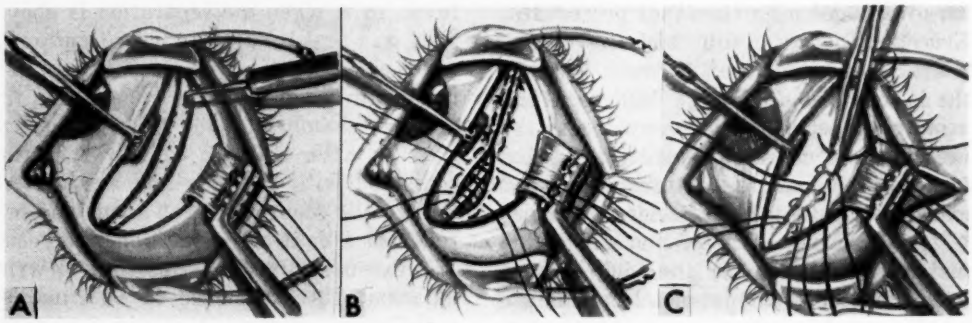

Fig. 5.—*A*, lamellar scleral resection. Lamellar strip of sclera is excised and multiple diathermy punctures applied within trough. *B*, lamellar scleral resection and use of polyethylene tube. Mattress sutures are inserted and small polyethylene tube is placed in resected area beneath sutures. *C*, sclera tented with forceps. Double-armed mattress sutures (No. 5.0 braided nylon) are used to hold buckle.

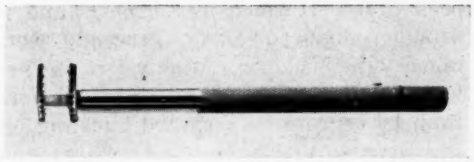

Fig. 6.—Scleral buckler (Berens) for producing external buckle in retinal detachment.

within the trough (Fig. 5*A*). Mattress sutures are inserted as in the classic lamellar resection operation. A small polyethylene tube is placed under the mattress sutures in the resected area, over the detachment and posterior to the tear. Subretinal fluid, particularly from around the "buckle," is evacuated with either a sharp discission knife or perforating diathermy. The tube is trimmed to lie within the trough, and the mattress sutures are tightened and tied (Fig. 5*B*).

The Schepens procedure is under study at several clinics, but statistical data on the use of polyethylene tubing by his method in operating for retinal detachment are still not available.

The inward scleral buckling with lamellar undermining, as proposed by Chamlin,[24] appeals to us if inward buckling is desired. Outward buckling may be most lasting and may offer a more satisfactory approach, but it is too early to evaluate its advantages over the other procedures. Everett[25] folds the full thickness of the sclera, inserts mattress sutures through the base of the fold (Fig. 5*C*), carefully avoiding penetrating the choroid with the needle, and excises the external buckle before tying the mattress sutures. We prefer external buckling with a scleral buckler* (Fig. 6), using No. 5-0 braided nylon mattress sutures to fix the fold, because with this technic the inner scleral surface and the overlying choroid should be flatter.

Opinion is divided as to whether to inject saline solution or air to increase intraocular tension, but few thus far have used vitreous. We prefer the injection of air. Increasing the intraocular pressure will insure apposition of the retina, smooth out folds, stretch vitreous bands and eliminate subretinal fluid as thoroughly as possible. It is claimed that too much tension may cause the sutures to break, or may tear the tissues, but we have not encountered either with the use of braided nylon sutures.

Vitreous transplantation, as suggested by Shafer[26] (Fig. 7*A*) has been successful in 48 per cent of 50 eyes for which previous operations failed. He has used vitreous implantation as a primary procedure for retinal detachment with excellent results, but has stated that his cases have not been observed for a sufficiently long postoperative period to evaluate the results from the statistical point of view. He has used vitreous preserved for weeks, however, with success, and expressed the opinion that vitreous bands are lysed by it.

McLean[19] stated that vitreous passed through a needle or orifice is markedly altered in its physical characteristics. The hope of finding a suitable artificial vitreous for implantation is being investigated by McLean and his co-workers.

Much earlier ambulation after operations for retinal detachment is gaining favor, even when the separation is above. This was first brought to our attention in 1930, when a patient was permitted to sit in a chair because of hemorrhage into the anterior chamber on the third postoperative day after a Gonin cautery operation combined with trephine and suction. Although the separation was above and had followed a cataract extraction, the result was excellent. Jervey[27] was first to write us about his experience in allowing his patients up earlier. Ophthalmologists in Boston, New York and on the Continent[23] now stress early ambulation.

Tears in the Retina Without Detach-

*Made by Storz Instrument Company, St. Louis, Missouri.

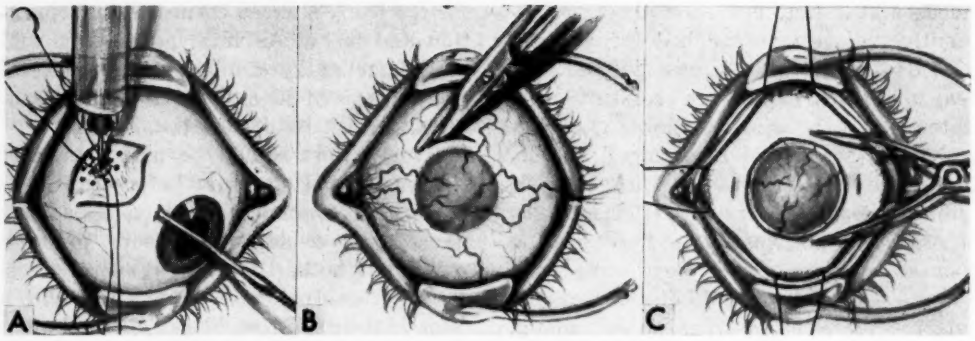

Fig. 7.—*A*, transplantation of vitreous. After scleral incision and introduction of two double-armed mattress sutures, appositionally placed, vitreous is injected into posterior chamber. *B*, total corneoscleral transplantation. Circumcorneal conjunctival incision is made 3 mm. from limbus. *C*, total corneoscleral transplantation. Traction suture is passed under each muscle and circumferential mark made on the sclera 3 mm. from the limbus.

ment: Our experience leads us to the conclusion that tears, when detected, should be closed before detachment develops. Colyear and Pischel[28] from a study of 25 patients, concluded that it is best to operate prophylactically, and our experience has demonstrated that this is the safer course.

Corneal Surgery.—Lamellar keratoplasty is being more generally employed abroad[29] and in the United States, not only for therapeutic purposes but to improve vision and as a preliminary operation before using a perforating graft. King's[30] method of preserving corneal tissue will facilitate wider universal employment of grafts, especially of the lamellar type. Many trends in corneal transplantation are briefly and clearly reviewed by Rycroft[29] and his collaborators. Some of the highlights follow:

Franceschetti and Maeder pointed out that the Shirmer test should be performed in order to determine that the lacrimal secretion is normal, and that if the secretion is abolished "the operation should be abandoned because of certain failure."

A point has been made by Barraquer of preliminary flattening of the cornea in the presence of keratoconus in order to cut a proper graft in this difficult condition. Paufique insisted that the great value of lamellar keratoplasty is well founded, and we also are convinced that most objections are unfounded, because of the advances in technic and the uses of antibiotics. The main argument against this type of corneal graft is the "unavoidable" opaque connective tissue which may remain behind the graft. We have observed that visual improvement follows the excision of a small central piece of Descemet's membrane and the endothelium before the donor graft is applied.

Sourdille cautioned against the use of sutures in "hot keratoplasties," the term used by him to designate an eye that is severely inflamed. Tassman's glue (plasma and thrombin) appears to Sourdille to favor vascular proliferation, and he has also recommended the use of plastic caps in all lamellar grafts, particularly therapeutic grafts. We have not been able to prove greater vascularization in 12 lamellar grafts in which "glue" was used but could see no real advantage over its nonuse.

Amsler has stated that his method of removing the donor corneal graft from the posterior surface produces a healthier graft because of lessened trauma. Mau-

menee stated that radiation therapy frequently makes a poorer bed for a graft than does a moderately vascularized cornea, and our experience confirms this statement. If the cornea is highly vascularized the graft should be as small as possible, to reduce the dose of antigen. Beta radiation may discourage the development of young budding vessels but has had little or no effect on old vessels. Cortisone should be used postoperatively to discourage vascularization when healing is well along. Rycroft stressed the fact that there is much more to learn concerning the entire subject of corneal grafting, but it is also most encouraging that the vision of so many patients with corneal lesions has been improved, and, with increased knowledge, more may be helped. We have long hoped that complete corneal grafting would be satisfactory, but in most cases the cornea becomes opaque sooner or later.

The method of total keratoplasty including a rim of sclera, however, proposed by Filatov in 1911, which has been disregarded but has recently been investigated and modified by Girard,[31] offers some hope for the badly scarred cornea. His preparation and technic of total penetrating and total lamellar keratoplasty with a scleral rim in cases of severe scarring and vascularization of the cornea follow:

Every effort should be made to lower the intraocular pressure before the globe is incised. Diamox, 250 mg., is administered for twenty-four hours preoperatively. Whether local or general anesthesia is used, akinesia is obtained with a Van Lint or O'Brien block. A retrobulbar injection of xylocaine, 2 per cent with hydrase, is made, followed by pressure on the globe for five minutes, the pressure being released every thirty seconds.

Local anesthesia is supplemented by a subconjunctival injection of xylocaine (2 per cent) and epinephrine (15 minims to the ounce). A circumcorneal conjunctival incision is made (Fig. 7*B*) and the conjunctiva is undermined and dissected back to expose the four rectus muscles.

A silk suture (10.4-0) is passed under each muscle for retraction. With maintenance of an approximate distance of 3 mm. from the limbus, a circumferential mark

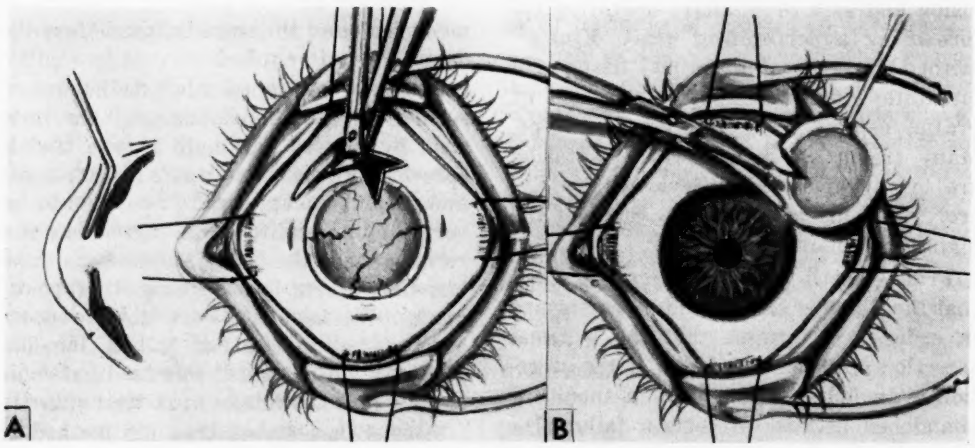

Fig. 8.—Total corneoscleral transplantation. On recipient eye, sclera is incised, choroid exposed and spatula inserted between choroid and sclera into anterior chamber. Sclera is incised vertically, followed by scleral dissection within marked area. *B*, cornea, together with sclera rim, is completely excised.

is made on the sclera with methylene blue, by means of a marking caliper (Fig. 7*C*).

Penetrating Graft: On the donor eye, the sclera is incised with a Lundsgaard knife along the marked line. The globe is entered with Stevens scissors, and the corneoscleral graft is excised anterior to the marking. All uveal tissue is carefully dissected from the inner surface of the cornea and sclera, and the graft is laid on a sponge saturated with saline solution and placed in a wide-mouthed bottle.

On the recipient eye a Lungsgaard knife is used to incise the sclera. When the choroid is exposed, a cyclodialysis spatula is inserted between the choroid and the sclera into the anterior chamber (Fig. 8*A*). A Bard-Parker knife (No. 15 blade) is used to incise the sclera vertically, overlying the spatula. The iris root and ciliary body are dissected free from the sclera down to and past the circumferential marking. The corneoscleral incision is completed with corneal scissors (Fig. 8*B*). The spatula is reintroduced as necessary to separate the sclera from the underlying structure. Any anterior synechiae are carefully separated from the cornea.

The donor graft is excised in a similar manner, except that the radial corneoscleral incision is omitted, and is placed on the recipient eye and sutured into place with multiple interrupted No. 4-0 chromic catgut. The anterior chamber is reformed with air (Fig. 9). The conjunctiva is brought down from above and up from below over the graft to within the pupillary area, and sutures are inserted at the horizontal extremities to prevent the conjunctiva from invading the pupillary area. Atropine ointment (1 per cent) is instilled, and both eyes are bandaged. Penicillin (100,000 units) and hydrocortisone (20 units) are injected subconjunctivally. Postoperatively, uveitis is controlled with metacorten, 5 mg. four times a day, or, if it is severe, intravenous ACTH is injected. If striate keratitis develops, it is a strong indication of death of the graft. Daily intravenous injections of ACTH and histamine diphosphate, 2.7 mg. in 500 cc. of saline solution may reverse the process.

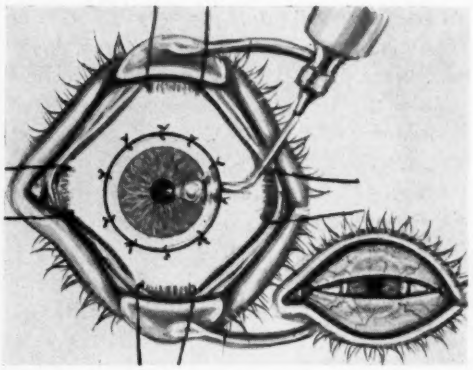

Fig. 9.—Donor graft sutured in place; anterior chamber reformed with air. Conjunctiva is drawn over graft to within pupillary area and is held in place with sutures inserted at horizontal extremities.

Lamellar Corneoscleral Transplantation (Girard Technic).—Lamellar corneoscleral transplantation is less hazardous than the penetrating transplantation and is indicated as an initial procedure whenever suitable. A lamellar transplant may be converted into a penetrating procedure if the case proves unsuitable for lamellar corneoscleral transplantation.

The initial steps in lamellar corneoscleral transplantation are the same as with the penetrating procedure. The incision is made with a Lundsgaard or Bard-Parker knife and is carried through two-thirds of the thickness of the sclera and to a point where the choroid and ciliary body show through the remaining fibers. The resection of scarred tissue is begun at 12 o'clock and is carried down over the limbus and into the corneal layers. Caution is exercised at the limbal area as the change in curvature invites penetration into the anterior chamber; however, every effort should be made to keep the incision

as deep as possible as multiple small penetrations are of no consequence. Excision of remaining scarred cornea down to Bowman's membrane is desirable using a double-edged hollow ground keratoplasty knife.[31] Suturing of the donor graft and fixation of the conjunctival flap is the same as for penetrating transplantation.

Seven eyes have been operated on by Maumenee[33] by the Girard technic of scleral corneal transplantation. Although it is early to judge final results, there has been some improvement in several of these otherwise hopeless cases. Maumenee stated that inclusion of the sclera eliminates the immediate postoperative edema that frequently occurs in large (10 to 12 mm.) corneal grafts; also that the operation may be done on eyes with secondary glaucoma and that the glaucoma seems to be controlled. He stated that the major complication, which seems to be uncontrolled at present, is delayed clouding of the graft. He is now working on methods of reducing this factor.

Ocular Muscle Surgery.—More surgeons are performing operations on the oblique muscles after careful study of the motor anomalies with orthoptic technicians and the use of preoperative and postoperative orthoptic training. Training is of great importance, as was pointed out years ago.[34] In our opinion, even with inadequate operation, good results often may be obtained if intelligent use of orthoptic training is employed by interested trained personnel.

Tucking the superior oblique, in our experience, is preferable to resection. The technic used is as follows:

The conjunctiva is incised over the center of the superior rectus muscle and extended temporally to the lateral rectus insertion. The eyeball is drawn forcibly downward and rotated temporally until the expanded tendon of the superior oblique at the scleral insertion is identified. It is usually unnecessary to free the superior rectus unless resection is indicated.

The superior oblique is undermined from its insertion nasally for a distance of approximately 5 mm. A tenotomy hook is passed beneath the muscle at its insertion, and a special ptosis and muscle forceps[35] is applied at a predetermined distance measured with special marking calipers (Fig. 10*A*).[36] Two double-armed braided white nylon sutures (No. 5-0) are looped on the posterior surface of the superior oblique and passed through the muscle forceps. The muscle forceps is used to overlap the superior oblique temporally, and the two double-armed braided nylon sutures are passed through the episclera temporally to the insertion of the superior oblique (Fig. 10*B*) and tied.

The conjunctival wound is closed with a running centrally locked No. 5-0 plain catgut suture.

In weakening the superior oblique, we prefer retroplacement of this muscle, but it seems to be rarely done (See Table 1).

Transplantation of the lateral halves of the inferior and superior rectus muscles to the lateral rectus muscle and displacement of the nasal halves of the muscle temporally is particularly useful in the treatment of paralysis of the lateral rectus.[37] Hill[38] recommended transplanting the superior and inferior recti farther temporally. A similar procedure is practiced when adduction is deficient, which splits and displaces the muscles nasally.

The importance of postoperative cicatricial adhesions between the muscles and the eyeball as the cause of postoperative cicatricial strabismus has been pointed out.[39] Tenon's capsule transplantation has been employed to overcome this difficulty, with definite improvement at convergence in 16 of 18 patients with postoperative cicatricial exotropia. Limitation of motion was improved in the majority of cases, being almost completely or only partially

corrected in 16. Complete restoration of function was obtained in 1 case and marked improvement in 9 eyes. The postoperative deviation showed an average improvement of 50 per cent in the exotropic patients and 66 per cent in the esotropic patients. Vertical imbalance was reduced postoperatively in one-third of the patients.

The importance of handling Tenon's capsule with care was stressed by Swan,[40] who performs an intracapsular recession and resection of the muscles. More recently, Fink[41] has introduced gelfilm between the muscles.

Glaucoma. — In cases in which intraocular surgical intervention is contraindicated, cycloelectrolysis, in our experience, is preferable to cyclodiathermy, because of the undesirable complications resulting from the latter. A number of ophthalmologists have abandoned cyclodiathermy because of the high percentage of atrophic globes and poor results obtained by its use. A questionnaire sent to members of the American Ophthalmological Society and to ophthalmologists abroad revealed that 19 per cent of 1,078 eyes became atrophic following cyclodiathermy, and phthisis bulbi occurred in an additional 9 per cent of these retained eyes, making a total of 28 per cent of eyes so affected.[42] Lachman and Rockwell[43] reported atrophy of the eyeball in 15 per cent of eyes in their series of cases, and deRoetth[44] observed 20 per cent of atrophy after cyclodiathermy in 20 per cent of the cases.

In a series of 264 eyes observed for one to fifteen years, for which anterior cyclodiathermy[42] was used as a primary procedure in 70 per cent of the cases, tension was controlled in only 4 per cent without miotics (25 mm. of mercury Schiotz) and in 24 per cent with miotics. Additional surgical treatment was required by 31 per cent of the eyes. The postoperative results

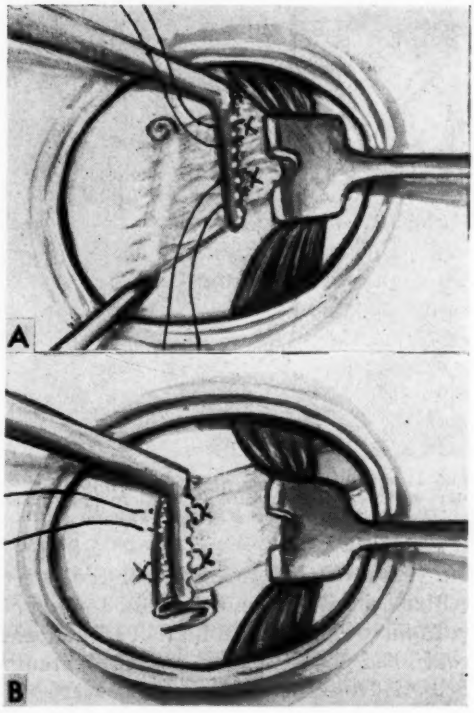

Fig. 10.—*A*, tucking superior oblique muscle. Superior rectus muscle is retracted, the superior oblique exposed and undermined. Tenotomy hook is passed beneath oblique at its insertion. Special ptosis forceps is applied at a predetermined distance measured with marking calipers. Double-armed braided nylon sutures are inserted back of the forceps and tied. They may then be passed through the suture tracks. *B*, forceps employed to overlap superior oblique temporally, and sutures are passed through episclera, temporal to insertion of superior oblique.

in 127 eyes observed for one to four years, in which retrociliary diathermy had been used as a primary procedure in 81 per cent, revealed 4 per cent of the eyes controlled (under 25 mm. of mercury) without miotics, and 22 per cent with miotics. Thirty per cent of these required additional surgical treatment to control tension.

Anterior cycloelectrolysis was performed as a primary procedure in only 35 per cent of 239 eyes observed for two to

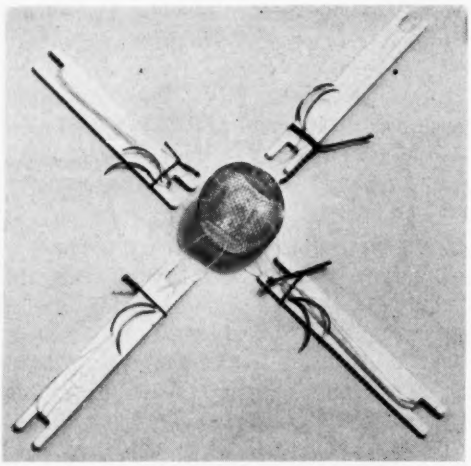

Fig. 11.—Hollow plastic intrascleral implant with steel mesh-cap and suture grooves for preplaced sutures for insertion after evisceration.

ten years. Of this series, 32 per cent were controlled without miotics and 33 per cent with miotics, making a total of 65 per cent controlled under 25 mm. of mercury Schiotz. Additional operations were required in 19 per cent of this series.

The incidence of atrophic globes following cycloelectrolysis was only 1 per cent, as compared with 11 per cent following anterior cyclodiathermy and 6.5 per cent following retrociliary diathermy in this series of cases.

When a filtering operation is indicated, we prefer iridocorneosclerectomy,[45] having had excellent results with this procedure for twenty-five years (Table 2). Iridencleisis, although simpler to perform than iridocorneosclerectomy, gives less consistently good and lasting results.

In a series of 501 eyes observed for one to fifteen years after iridencleisis, only 14 per cent were controlled without miotics and 38 per cent with miotics—a total of 52 per cent controlled under 25 mm. of mercury Schiotz. The postoperative complications following iridocorneosclerectomy were not so serious as those following iridencleisis. In 4 cases of this series sympathetic ophthalmitis was observed following iridencleisis,* and 2 additional cases were reported by Mackie and Rubinstein[46] in a series of 110 cases of acute congestive glaucoma.

Evisceration.—We encourage more surgeons to employ evisceration because, when indicated, evisceration is preferable to enucleation; it is less traumatic than the latter procedure, and there is less likelihood of atrophy of the orbital tissues with consequent sinking of the upper eyelid. The six extraocular muscles are left undisturbed, their usual anatomic and functional relations being thus preserved which assures a more nearly normal mobility of the stump.

Ruedemann[47] seems to have produced excellent results, with only 10 failures in 200 cases, by employing his modified Burch evisceration with retention of the cornea. Poulard,[48] however, used the "older method" of retaining the cornea only in cases of diminution of the volume or atrophy of the globe, when the sclera alone did not suffice to surround the sphere or ovoid with sufficient space to allow for shrinkage. King[49] informed us that of approximately 12 eyes he had observed on which the old Burch method of evisceration had been performed, 7 required enucleation because, in spite of medication, these eyes were congested and painful. King attributed this complication to friction over the cornea as well as to the possibility that the patients had not been hospitalized or treated adequately while in Korea. The fact that Hughes[50] also reported necrosis of the cornea following the Burch evisceration with retention of the cornea discouraged us from employing this technic.

Rosa developed a hollow plastic implant which is spherical on the posterior two-thirds and flattened on its anterior sur-

*One questionable case, N. Y. Eye and Ear Infirmary, 1 case Wills Eye Hospital, and 2 cases of severe uveitis, possibly sympathetic ophthalmitis, courtesy of Dr. F. H. Adler.

face, so that retraction of the sclera produces a flat surface anteriorly. The motion of the prosthesis is increased when its posterior surface is also made flat, because it impinges upon the flattened surface of the stump. This arrangement imparts more motion to the prosthesis than when the surfaces are curved. We have retained the shape of the Rosa implant but have covered the flattened anterior surface with steelmesh.

Suture grooves have been added, through which double-armed braided white nylon sutures are preplaced (Fig. 11). The implant is inserted into the scleral cavity after the introduction of mattress sutures No. 5-0 braided white nylon) through the sclera, and then the sutures are tied. This assures firm adhesion between the tissues and the implant, thereby preventing rotation of the implant.

Extrusion of 5 of the implants was caused by implants too large for a shrunken globe and for an infant eye (only the adult size implant was available at the time); in 1 case it was due to a large blood clot behind the implant, in 1 to severe intraocular hemorrhage and in the fifth "probably to necrosis of the posterior segment of the globe."

Excellent results have been obtained in 131 cases and fair results in 8 of a total of 144 eviscerations with use of the Rosa and the Rosa-Berens implant,[51] which may be obtained in three sizes (adult, juvenile and infant).* No case of sympathetic ophthalmitis was observed either in this series of 144 eyes observed for approximately five years, or in the series of 200 cases reported by Ruedemann. Poulard stated that "the agitation caused by the spector of sympathetic ophthalmia has for a long time retarded the progress of eye surgery." Gat[52] and Summerskill[53] have both maintained that the danger of sympathetic ophthalmia is eliminated by proper evisceration technic.

*Made by American Optical Company, Southbridge, Mass.

SUMMARY

Some of the recent trends and advances in ophthalmic surgery are briefly reviewed. It is suggested that limbal based flaps and the use of preplaced mild chromic catgut sutures subconjunctivally is the safest method of wound closure in operation for cataract today. The trend is toward round pupils; complete basal iridectomy is resorted to when there has been inflammation or when glaucoma exists or is feared.

Indirect ophthalmoscopic study and scleral depression are being used with increased frequency to localize retinal tears, and diathermy seems to be preferred for producing adhesions between the choroid and the retina except in flat detachments, for which catholysis is employed by some. The use of pins in surgical detachment of the retina is valuable, but they should be inserted after, not before, the application of perforating diathermy.

Lamellar scleral resection and scleral (inward and outward) buckling are gaining favor. Direct sutures or monel clips are used, with and without polyethylene tubing. External buckling and direct sutures are favored by the authors.

Vitreous transplantation, as reported by Shafer, has been successful in his hands in 48 per cent of 50 eyes in which previous retinal detachment had failed. The authors agree with the trend toward early ambulation after retinal detachment, and, although some surgeons have discarded the postoperative use of pinhole glasses, the authors consider them valuable.

Lamellar keratoplasty is more generally employed for visual and therapeutic purposes. It is safer than penetrating keratoplasty. King's method of preserving

grafts will facilitate the wider use of keratoplasty, and especially the lamellar operation. The Filatov operation, in which a rim of sclera is included, has been discarded. Girard has modified this technic and employed it with fair success in 12 apparently hopeless eyes. His technic for total penetrating and total lamellar keratoplasty with a scleral rim is described.

A point has been made by Franceschetti that the Shirmer test should be performed in all cases in which a corneal transplant operation is contemplated, to determine whether the lacrimal secretion is normal. If the secretion is abolished the operation should be abandoned, because of certain failure.

Preliminary flattening of the cornea in the presence of keratoconus is suggested, to enable one to cut a graft of the proper size.

The vision of many patients with corneal lesions has been improved, but there is still much to learn concerning the entire subject of corneal grafting.

Many more operations are being performed on the oblique muscles, especially after careful study of the motor anomalies and with preoperative and postoperative orthoptic training. When indicated, tucking of the superior oblique is preferable to resection. The tucking technic is briefly outlined, and a table of the results of surgical treatment of the obliques is given.

Transplantation of the lateral halves of the inferior and superior rectus muscles to the lateral rectus muscle and displacement of the nasal halves of the inferior and superior recti temporally is indicated in the presence of paralysis of the lateral rectus. A similar procedure is useful when adduction is deficient, the transplantation being made nasally.

Care should be exercised with Tenon's capsule to prevent postoperative cicatricial adhesions. Gelfilm may be placed between the muscles, or Tenon's capsule may be transplanted, to forestall this condition. Tenon's capsule transplant is also used to correct postoperative cicatricial strabismus. Improvement in convergence was reported in 16 of 18 patients with postoperative cicatricial exotropia after this procedure, and adduction and abduction were improved in the majority of these cases.

The high incidence of atrophic globes (from 15 to 28 per cent) and other undesirable complications following cyclodiathermy for glaucoma have led some ophthalmologists to abandon this procedure. It is suggested that, in eyes for which a filtering operation is contraindicated, cycloelectrolysis should be performed. Aside from the fact that less serious complications result from cycloelectrolysis than those following anterior or posterior cyclodiathermy, tension was controlled in a larger percentage of cases after cycloelectrolysis (of 239 eyes observed for one to ten years, 65 per cent were controlled under 25 mm. of mercury with and without miotics) as compared with cyclodiathermy (or 264 eyes observed for one to fifteen years, 20 per cent were controlled under 25 mm. of mercury with and without miotics).

The results following iridocorneosclerectomy for glaucoma in 511 eyes observed for one to twenty-five years reveal that 77 per cent of the eyes were controlled with and without miotics. Comparing these results with those in 501 eyes observed for one to fifteen years after iridencleisis, in which 52 per cent of the eyes were controlled (under 25 mm. of mercury Schiotz), with and without miotics, indicates that iridocorneosclerectomy is the preferable procedure. Complications following iridocorneosclerectomy are less serious than those following iridencleisis, especially because sympathetic ophthalmitis has been reported by several authors.

The results and postoperative complications in 9 eyes after the Ridley lens im-

plant indicates that the hazards involved are such as to make this procedure unjustifiable, especially because of the good functional results that usually follow the use of contact lens and orthoptics. Four of the lenses in this small series were removed postoperatively, and for an additional eye the removal of the Ridley lens was suggested. Glaucoma developed in 5 of the eyes and severe iritis in 1, which was thought to be possibly sympathetic ophthalmitis. Chronic uveitis occurred in 1 eye and occlusion of the pupil in 3. Operations by Reese have been more successful, but conservatism is advised in implanting plastic, because of the satisfaction usually obtained with contact lenses.

Patients in whom the Strampelli and the Salleras lenses were inserted into the anterior chamber have not been observed postoperatively for a sufficient length of time for proper evaluation. The procedure, however, is simpler to execute than the Ridley implant; fewer complications are reported, and thus far, apparently, the postoperative results are superior. A brief case history is presented, and a technic in which a Strampelli lens was inserted because of an extremely shallow anterior chamber and anterior synechiae after cataract extraction and corneal tranplantation is recorded.

Ruedemann reported only 10 failures in 200 cases in which he employed a modified Burch evisceration with retention of the cornea. Excellent results were obtained in 131 of a total of 144 cases in which the Rosa-Berens hollow plastic implant was employed and fair results in 8 cases when the cornea was excised. Although extrusion of the implant was reported in 5 of the early cases, this complication seems to have been overcome by a modification of the technic and the development of implants in three sizes. Sympathetic ophthalmitis has not been observed in the 200 cases reported by Ruedemann, nor was it encountered in the series of 144 cases in which the Rosa-Berens hollow plastic intrascleral implant was inserted. It is recommended that, whenever indicated, evisceration should be performed rather than enucleation, because of better cosmetic results and more nearly normal motility of the prosthesis.

CONCLUSION

All surgical procedures, to be accepted, must withstand the test of time and must have been performed in a sufficient number of cases to be critically and statistically evaluated. Although some of the newer technics seem to produce better results than do the older procedures, more research and clinical investigation is needed if functional and visual results are to be improved and unnecessary blindness prevented.

CONCLUSION

Todo procedimiento quirúrgico, para se aceptado, debe pasar la prueba del tiempo, y debe haber sido empleado en suficiente número de casos para poder ser crítica y estadísticamente calculado. Aunque ciertas técnicas nuevas parecen producir mejores efectos que las antiguas, se precisan nuevas investigaciones clínicas para mejorar los resultados funcionales y visuales, así como para prevenir la ceguera innecesaria.

CONCLUSIONS

Avant leur adoption toutes les techniques chirurgicales doivent subir lépreuve du temps et avoir fait leurs preuves. En chirurgie oculaire il semble que certaines techniques nouvelles demandent des recherches plus poussées si l'on veut obtenir de meilleurs résultats et éviter une cécité.

CONCLUSIONE

Qualunque metodo chirurgico, per essere accettabile, deve essere stato vagliato in base ai suoi risultati a distanza e deve

essere stato impiegato in un numero sufficiente di casi.

Benchè alcune tecniche moderne sembrino conseguire risultati migliori di tecniche più antiche, tuttavia sono necessarie ulteriori indagini per perfezionare ulteriormente i risultati funzionali e per prevenire cecità evitabili.

SCHLUSSFOLGERUNG

Alle chirurgischen Massnahmen müssen, um allgemein anerkannt zu werden, für längere Zeit geprüft werden und, um kritisch und statistisch ausgewertet zu werden, an einer ausreichenden Zahl von Fällen durchgeführt werden.

Wenn auch manche der neueren Techniken bessere Erfolge aufzuweisen scheinen als die älteren Methoden, so bedarf es doch noch weiterer wissenschaftlicher und klinischer Forschung, um die funktionellen und visuellen Ergebnisse zu verbessern und um unnötiges Auftreten von Blindheit zu verhüten.

CONCLUSAO

Diz que todos os métodos cirurgicos para serem aceitos devem passar pela prova do tempo bem como devem ser realizados em numero suficiente de casos para serem creitica e estatísticamente avaliados. Embora al uno métodos novos paraçem superiores a antigos processos é necessario mais pesquiza e investigação clínica se os resultados funcional e visual devam ser melhorados e feita a prevenção da cegueira.

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Otorhinolaryngologic Surgery

Congenital Cysts and Fistulas of the Head and Neck

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A CLASSIFICATION of congenital cysts and fistulas of the head and neck should be based on the embryopathologic analysis. According to their origin from germ layers they may be divided into ectodermal, entodermal and mesodermal.

Ectodermal.—Epidermoids may be congenital or traumatic. The congenital cysts are derived from displaced ectodermal elements which develop into epithelium-lined pouches. They are located deep in the corium and most commonly in the midline along the embryonic lines of closure. Frequent sites of occurrence are the root of the nose, the lower lip and the floor of the mouth.

Histologically, the wall of the cyst is composed of fibrous tissue lined by stratified and cornified epithelium covered by keratin, and does not contain glandular elements or hair follicles. The contents are made up of keratin lamellated, serous or caseous material.

Similar to epidermoid cysts and of the same origin from displaced ectodermal rests are true cholesteatomas, which may be cranial and intracranial. Histologically, the capsule is lined by stratified squamous epithelium and the contents are represented by the products of desquamated epithelium in concentric laminae with a considerable amount of cholesterol.

Dermoid cysts are always congenital. They arise from inclusions of epidermis at embryonal fissures and clefts and result in a disturbance in the closure over the anomaly. They are, therefore, situated deeper than epidermoid cysts, under the skin, and may be associated with erosions or defects of bony structures. Frequent sites of occurrence are the lines of closure of the nasal bones, the skull and the external auditory meatus. They may appear clinically over the dorsum of the nose, in the internal and external canthi of the eye, in the eyelids and conjunctiva, in the orbit, in the ear, in the nasolabial fold and in the neck.

Histologically, the cyst wall is composed of fibrous tissue lined by epidermis including rudimentary sebaceous and sweat glands and hair follicles. The contents are represented by keratin, sebaceous materials and hairs.

Mucoid or congenital nonodontogenic ectodermal epithelial cysts originate from epithelial remnants that become imprisoned in facial clefts. For this reason they are also called fissural cysts or facial cleft cysts. They occur in the maxillary bones, and, according to Thoma,[1] they

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may be divided as follows:

a. *Median cysts,* which occur in the median fissure of the maxilla or mandible and may be subdivided into:
   1. Alveolar median cysts, which arise between the two globular processes forming the premaxilla
   2. Palatal median cysts, which form in the posterior part of the palate
b. *Globulo-maxillary cysts,* which form at the juncture of the globular and maxillary processes, between the roots of the lateral incisor and the canine
c. *Nasoalveolar cysts,* which are located at the juncture of globular, lateral nasal and maxillary processes at the attachment of the nasal alae
d. *Nasopalatine cysts,* which form in the nasopalatine duct and may be subdivided into
   1. Incisive canal cysts
   2. cysts of the papilla palatina
e. *Cysts of the vomeronasal organ of Jacobson* (when this organ persists as an epithelially lined pouch or a submucous tunnel).

Histologically, the cyst wall in the anterior varieties is lined by oral squamous epithelium, while in the posterior variety it may be lined either by the squamous or a respiratory type of epithelium. The contents are seromucous, and there is an absence of cholesterin.

Follicular or congenital odontogenic ectodermal epithelial cysts form from the stellate reticulum during amelogenesis, and the outer layer of the enamel organ forms the lining epithelium of the cyst. They occur in the maxillary bones and arise either from the follicle of a developing tooth or from supernumerary sprouts of the laminae or epithelial cell rests.

Follicular cysts are usually classified as follows:

a. Primordial cysts or simple follicular cysts, which arise from odontogenic epithelium before the differentiation to excreting enamel and are not related to a tooth.
b. Dentigerous cysts, which form during the development of the teeth and contain the crown of a tooth; they may be of the central or lateral type.
c. Multilocular cysts, which occur when several tooth buds take part in the cyst formation.

Histologically, the cyst wall is composed of fibrous connective tissue lined by a stratified squamous epithelium which is frequently cornified. The contents are represented by yellowish fluid. The dentigerous cysts contain the crown of the erupting tooth.

Salivary gland cysts and fistulas may be congenital or retention cysts. Congenital cysts of the salivary gland are rare and are considered similar to congenital cysts of the kidney. Their frequent site of occurrence is the upper pole of the parotid. The cyst wall is composed of fibrous tissue lined by a cuboidal epithelium with papillary projections. Cysts of the lacrimal gland are rare. Fistulas of the lacrimal sac may develop from epithelial connections between the sac and the surface.

Branchiogenic cysts and fistulas originating from the branchial region will be the object of further discussion in this paper.

Entodermal.—Pharyngeal "bursa" is a congenital anomaly that originates from adhesions of the upper end of the notochord to the pharyngeal entoderm. The cyst wall is lined by ciliated, pseudostratified columnar epithelium and contains a clear serous mucoid secretion. These bursae should be differentiated from the

rare fistulous tracts and cysts of Rathke's pouch, which are situated more rostrally and are of ectodermic origin.

Laryngeal cysts are congenital or acquired. The congenital cysts are from displaced entodermic and mesodermic cell rests and appear along the lateral wall of the larynx and around the epiglottic folds. The thin cyst wall is lined by simple or pseudostratified columnar or by a stratified squamous epithelium. The cysts contain serous or mucoid material.

Branchiogenic cysts and fistulas and *thyroglossal cysts and fistulas*, which are of prime importance to this paper, will be treated separately and in conjunction with their management.

Mesodermal.—Congenital cysts of mesodermic origin in the head and neck are mainly represented by hygroma colli or lymphangioma cystica. Their origin is from a developmental anomaly of the primary lymph spaces. These are multiple thin-walled cysts with colorless or yellow fluid.

The purpose of this paper is to analyze a group of congenital cysts and fistulas of the head and neck and to discuss their embryologic aspects, clinical implications and the management.

The conditions for consideration are dermoid cysts and fistulas of the nose and the preauricular sinuses, and fistulas, branchiogenic and thyroglossal.

Dermoid Cysts and Fistulas of the Nose.—Dermoids of the nose are no longer considered a rarity. The first 2 cases were reported by Lawrence[2] in 1837; several papers on the subject were published in the European literature toward the end of the last century and at the beginning of the present one. During the past two decades many cases of nasal dermoids have been recorded

A review of the world literature revealed over 100 cases of dermoid cyst of the nose, though not all of them were reported with adequate information. The incidence is less than 1 per cent of all dermoid cysts and slightly over 2 per cent of cysts of the head and neck.[3] This may vary, as New and Erich[4] reported that 13 of 103 dermoids of the head and neck occurred in the nose.

These anomalies, however, are still unusual and interesting enough to warrant further considerations. In most cases they are still too often not diagnosed or are inadequately treated until evaluated by someone who recognizes the condition and handles it correctly, being aware of its embryologic background and its morphologic variations. A review of the literature suggests that the majority are diagnosed primarily as "just a pimple."

The study of 6 cases of dermoid cysts of the dorsum of the nose prompted an investigation of this entity, the object being to analyze the origin and the clinical, radiologic, therapeutic and histologic aspects of these congenital cysts.

Embryologic Background.—The study of nasal morphogenesis reveals that dermoid cysts of the nasal structures originate from ectodermal displacement during intrauterine life. How this developmental deviation occurs is unknown.

Evans[5] in 1911 maintained that dermoid cysts are related to incomplete closure of the bilateral segments making up the nasal structures. Skin-lined depressions or canals on the midline of the nose are present, with cysts that would originate by closure of these fistulas with inclusion of the ectodermal elements.

According to Schaeffer[6] (1920), dermoid inclusion cysts of the nose develop from the persistence of epithelial cell strands in the line of fusion of the facial processes.

Brunner et al[7] (1947) supported Gruenwald's theory (1910) of *ectodermal displacement* in the "prenasal space" situated between the nasal bones and the anterior wall of the cartilaginous fetal nose.

When the nasal bones are formed in the dural connective tissue that covered the cartilaginous nose, parts of the ectoderm do not become separated and exist in the prenasal space. These displaced parts of ectoderm may advance to the formation of dermoids, with the development of a primary fistula if they remain in connection with the skin; a secondary fistula may develop after an infective process in the cyst. This sequence of events is similar to that accepted for the origin of dermoid cysts of the scalp, due to an ectodermal displacement during the intramembraneous formation of the cranial bones.

Tonndorf[8] in 1953 maintained that dermoid cysts of the nose originate from a disturbance in fetal fold development in the azygoid frontal process.

Beau, Neimann and Gosserez[9] have recently (1954) supported Lannelongue's theory (1891) of the intracranial origin of dermoid cysts of the dorsum of the nose. At the end of the third week the anterior neuro pore, or cephalic opening of the neural tube, closes, forming a recess that is in contact with the overlying ectoderm. Ectodermal elements may persist between the cutaneous plane and the neural tube as a diverticulum or a cord. These inclusions during development reach the glabellar region and are displaced further down toward the tip of the nose by the median, unpaired frontonasal process, and represent the anlage of the dermoid cyst of the nasal dorsum. This hypothesis explains the presence of fistulas and cysts, the position in the midline from the glabella to the tip of the nose and the occasional presence of a connection with the base of the skull. Dermoids of the nose and pilonidal sinuses are to be considered the same entity occurring in different sites.

Clinically, dermoid cysts of the nose are usually present at birth, but they may not become evident until much later. If the ectodermal inclusions are microscopic at birth, during the growth the products of desquamated epithelium and skin appendages became trapped within the center of the mass that presents itself as a cystic formation. Trauma may activate the process of development and growth. Other congenital anomalies are seldom associated, and heredity plays a minimal part. There seems to be a male predominance.

The cyst presents as a localized swelling in the midline from the glabella to the tip of the nose, with its greatest incidence on the upper part of the dorsum. The swelling is usually globular, fluctuant to palpation and not adherent to the skin. The lesion may also present as a pimple or a dimple on a slightly broadened nose. Trauma, infection and manipulation are generally followed by multiple fistulas. If a fistula is present, frequently sebaceous material and sometimes hair may come from the opening. An infection or the intermittent discharge is most often the cause of concern for the patient. In the majority of these cysts there is a sinus tract that involves the frontal or the nasal bones and the cartilages of the nose.

In differential diagnosis, from epidermal and sebaceous cysts, meningocele, lipoma and other connective tissue tumors, as well as specific chronic diseases, should be considered.

Roentgenographically, plain films may show the soft tissue swelling and bone destruction or irregularity if present. The injection of radiopaque substances into the skin opening, however, may reveal the course of the sinus tract and the cyst.

Therapeutically, incisions and cauterizations are to be avoided because of danger of cavernous sinus thrombosis and its recurrence. The only adequate treatment of dermoid cysts of the nose is total

surgical excision. Longitudinal or transverse incisions are to be used, according to the site and extent of lesion, in order to achieve optimal esthetic results. The injection of a contrast medium under pressure may sometimes help to identify the sinus tract, but if there has been previous infection it results in distortion of the anatomic structures. The removal of uncomplicated cysts and sinuses is usually easy and effective. Cases in which there has been previous infection or manipulation may present difficulty in identification of the sinus tracts and stalk, owing to the scar tissue, and the sacrifice of bony or cartilaginous structures may be necessary.

Histologically, dermoid cysts of the nose are lined by cornified, stratified squamous epithelium. In the subepidermal tissue there are sebaceous and sweat glands and hair follicles. The lumen contains keratin, scaly and sebaceous material and hair.

If there is no fistula, the best surgical approach is that of the typical rhinoplastic procedure. Transfixation of the septum allows better visualization, with subsequent good results, and no external incision is required. In the presence of a fistula, however, this method is not practical, since the tract must be excised including the skin.

Preauricular Sinuses and Fistulas. — The interpretation of preauricular sinuses and fistulas requires an understanding of the embryologic history of the external ear.

The external ear originates from the first branchial groove, with additions from the mandibular and hyoid arches, which appear in an embryo of three weeks' development. The first groove is the only branchial groove that remains connected with the surface; the others are obliterated in the cervical sinus.

The external auditory meatus represents the first branchial groove, whose blind end comes to abut against the wall of the tympanic cavity, separated by the tympanic membrane.

The auricle is formed from the coalescence of the six tubercles that develop during the sixth week on the caudal border of the first and second branchial arches. These six hillocks have only a topographic significance, as there is no definite agreement as to the anlage of the several segments of the pinna.

Preauricular sinuses and fistulas are congenital anomalies derived from incomplete closure of the clefts between the primordia of the external ear, either the first groove itself or the colliculi brachialis.

A fistula auris may therefore be considered an expression of a superiorly placed branchiogenic fistula. According to some authors,[10] branchiogenic cysts and fistulas are to be divided according to their topographic situation; upper location from the supra-auricular region to the angle of the mandible, middle location from the mandibular angle to the upper border of the thyroid cartilage and lower location from the thyroid cartilage to the clavicle.

Clinical Aspects.—Preauricular pits or sinus tracts are usually recognizable at birth but may be asymptomatic and do not draw any attention. They are characteristically observed in front of the pinna, usually involve the ascending limb of the helix and are often bilateral. The fistula may vary in length and in complexity, and an extension of the tract in the substance of the parotid gland is not infrequently observed upon removal. The patient usually gives a history of occasional discharge of secretion or fluid from the opening. As long as the condition remains asymptomatic, however, patients fail to seek medical care, but if, as a result of closure of the ostium, trauma or manipula-

tion, the fistula becomes infected or, as a cyst it becomes distended, treatment is sought.

Extremely rare forms of fistula auris are complete fistulas connecting the preauricular area with the middle ear cavity and the pharynx and also the fistula collo-auralis with two openings, one in the preauricular area and the other in the neck. The last-mentioned fistulas are to be considered remnants of the first branchial cleft.

Probing and radiographic visualization by means of radiopaque substance may be useful in detecting the course of the sinus tract in selected cases. The scarring process following repeated infections may cause distortion and prevent adequate visualization of the tract.

Treatment. — Asymptomatic fistulae auris usually do not require any treatment. They may, however, be removed for esthetic reasons.

Previously infected fistulas or cysts should be excised surgically after the flare-up has subsided. Dilations of the ostium, cauterizations and simple incisions result in recurrence and further cosmetic deformity.

The surgical excision should be complete and accurate. The preoperative use of a dye, such as methylene blue, may occasionally be helpful but often has the disadvantage of obscuring the operative field. Longitudinal incisions in front of and parallel to the tragus are preferred for esthetic purposes, but great care should be taken to avoid injuring the facial nerve.

The removal of uncomplicated fistulas can be accomplished with ease, but often the scarring process following infection and inadequate removal may cause marked difficulty in visualizing the tract, which usually is branched and irregular. The sacrifice of segments of cartilage or parotid gland is at times a necessity and may require additional surgical measures to repair the defect.

Histologically the sinus tracts or cysts are lined by the sort of stratified squamous epithelium usually associated with subepithelial inflammatory changes. Lymphatic tissue beneath the epithelial lining was found in one of our cases of preauricular cyst of branchiogenic origin.

Branchiogenic Cysts and Fistulas. — *Branchiogenic cysts and fistulas* arise from incomplete absorption of included ectodermal and entodermal elements that are buried during the morphogenesis of cervical structures of branchiogenic origin. Interpretation and treatment of these disturbances require a description of the embryologic background of the branchial region.

In an embryo of three to four weeks, the five branchial arches develop on the lateral surface of the neck. Each arch contains a cartiliginous structure, and aortic vascular arch, muscles and nerves. The arches are separated externally by the branchial grooves (of ectodermal origin) and internally by the pharyngeal pouches (of entodermal origin).

The last four arches are the anlage of most of the cervical structures.

The second arch grows rapidly downward, telescoping the other caudal arches and enclosing the lower branchial grooves in a precervical sinus, which normally becomes obliterated by the fifth or sixth week. If any of the ectodermal elements lining the walls of the precervical sinus become buried in the neck, a tumor, a cyst or a fistula may develop.

Among the pharyngeal pouches, the most important is the third, which gives rise to the thymus and inferior parathyroid gland via the thymopharyngeal duct. The persistence of fragments of this duct would explain the origin of lateral cysts and fistulas of the neck.

Two main theories have been presented

to explain the origin of branchial cysts and fistulas.[11] The first, the branchiogenic theory, explains their origin as complete or partial failure of a cleft to close, and the cyst itself being a developmental anomaly from epithelial rests of the cleft walls.

The second theory propounds the origin of branchial cysts and fistulas below the level of the hyoid bone, from the thymal duct.

Both embryonic vestigia are to be considered possible anlagen of lateral cervical fistulas and cysts. Their differentiation relies on careful examination of their anatomic relations, particularly to the main vascular and nervous structures of the neck, and on microscopic examination after removal.

The origin of these anomalies from ectodermal rests derived from the epithelial placodes associated with the ganglion of nerves of the arches has also been considered.[12]

Bailey[13] classified branchial cysts into four groups: (1) cysts that lie at the anterior border of the sternocleidomastoid muscle; (2) cysts that extend deeper and lie on the great vessel, being often adherent to the internal jugular; (3) cysts that may reach the lateral wall of the pharynx, passing between the external and internal carotid arteries, and (4) cysts that lie on the pharyngeal wall behind the common carotid.

The fistulas may be subdivided into three forms: (1) sinus tract, open externally; blind internally; (2) sinus tract, open internally, blind externally, and (3) fistulous tract, open internally and externally. The anatomic relations of the fistulas correspond to those of the cysts.

The key points in differentiating the lateral vestigial cysts and fistulas of the neck are based on anatomic and histologic grounds. Cysts and fistulas of branchiogenic origin are derived mainly from the second cleft and pass between the internal and external carotid arteries; the internal opening of a fistula is in the tonsillar fossa. Branchiogenic cysts in close contact with the tail of the parotid may be of first cleft origin. Cysts and fistulas from the thymopharyngeal duct lie anterior and very close to the carotid sheath; the internal opening of a fistula is in the region of the pyriform fossa. Both types of fistula have external openings at the anterior border of the sternocleidomastoid muscle.

Histologically, cysts and fistulas of branchiogenic origin are lined by squamous epithelium, although columnar or ciliated epithelium may be present. Cysts and fistulas of thymic origin contain thymic tissue with Hassall's corpuscles, and both types of cysts and fistulas usually contain lymphoid tissue of reactive origin.

Branchiogenic Cysts: Clinical Aspect.— Branchial cysts are usually observed in the upper lateral region of the neck, below the angle of the mandible and along the anterior border of the sternomastoid muscle, while branchial fistulae are commonly present in the lower part.

Such a lesion usually develops in childhood or early adult life as a discrete, easily movable swelling along the anterior border of the sternocleidomastoid muscle. As it is painless, it may be allowed to grow to a conspicuous size, sometimes becoming elongated downward along the sternocleidomastoid muscle or upward, bulging into the floor of the mouth.

Occasionally, a patient states that a cyst developed after an infection of the upper part of the respiratory tract, a tonsillectomy or an injury to the neck. While it is possible that these events may attract the patient's attention to a pre-existing cyst, it may also happen that a cyst develops from closure of an unknown internal sinus tract. Dysphagia and dysphonia are

complaints associated with large cysts.

Spontaneous infection is rare, but suppuration may follow upon incomplete removal, repeated aspirations, roentgen therapy or sore throat. Infection yields to adhesions of the cysts to surrounding structures.

Not infrequently a branchiogenic cyst develops rapidly, increasing the diagnostic problem. Differential diagnosis should take account of dermoid cysts, cystic hygroma, tuberculous lymphadenitis, thyroglossal tract cysts, lipomas, cavernous hemangiomas, nonchromaffin paragangliomas, metastatic lymphadenopathy, aberrant thyroid neoplasms and neurofibromas.

Treatment.—Complete surgical excision of the cyst and possible tract is the only treatment.

Incision and drainage, as well as incomplete removal, encourage recurrence with sinus tract formation. Sclerosing solutions, repeated aspirations and roentgen therapy are ineffective and may cause severe infection.

Owing to the anatomic relation of these cysts to the nervous and vascular structures of the neck, their excision is to be considered a major procedure. Adequate exposure is absolutely mandatory.

The skin incision may be transverse or along the anterior border of the sternocleidomastoid muscle, according to the site and size of the cyst. If definition of the tract is difficult it is best to open the cyst, drain the contents and inspect the sac for possible openings indicative of tracts.

Because of its proximity to the great vessels, one is inclined to extreme caution in the dissection.

Histologically, the cyst is lined by stratified squamous epithelium or pseudostratified columnar ciliated epithelium. Papillary projections may also be noted. The wall is rich in lymphatic tissue, frequently arranged in follicles.[14] The surrounding fibrous tissue varies in thickness according to the degree of previous infection and determines the consistency of the structure. Muscle fibers and cartilage in the wall are considered remnants of the original branchial apparatus.

The content is usually semisolid or clear fluid, but occasionally it may be milky or watery. According to Bailey,[13] the presence of cholesterol crystal in aspirated material is diagnostic of branchial cyst.

Branchiogenic Fistulas: Clinical Aspect.—In contrast with branchiogenic cysts, sinuses and fistulas present clinical symptoms at birth or in early infancy.

Branchiogenic fistulas, as has been mentioned, are divided into three groups: (1) incomplete external fistula or external sinus that has only an opening; (2) incomplete internal fistula or internal sinus that has only an opening into the pharynx, and (3) complete fistula with an external and an internal opening.

The most common is the first, in which there is a sinus tract that opens externally through a tiny orifice, from which a small amount of secretion may exude at irregular intervals. Often there are no other symptoms of its existence than the appearance of this fluid from time to time from a small dimple in the lower part of the neck. Unless infection produces swelling of the entire tract, only surgical exploration, probing, or instillation of radiopaque material and roentgen studies will reveal the sometimes remarkably long fistulous tract existing in the neck of an otherwise symptomless patient.

Rarely, the branchial fistula develops without an external opening but with an opening into the pharynx, usually in the region of the tonsillar fossa or the lateral pharyngeal wall.

The third form of branchial fistula is the one which is truly a fistulous tract rather than a sinus, with both an internal and an external opening. The former is

situated in the region of the tonsil, or in the pyriform fossa, and the latter in the neck, commonly along the anterior border of the sternocleidomastoid muscle.

The diagnosis of a branchial fistula is usually not difficult, although in some patients the external opening may be so tiny that it may be overlooked for a long time. If it is infected, there are swelling, redness and tenderness about the external orifice.

Occasionally the fistulous tract which also opens into the pharynx will be so large that swallowed liquids trickle through it to the neck. Rarely, a patient may complain of symptoms referable to vagal stimulation when the tract becomes infected or is being probed or injected. Among these symptoms may be palpitation of the heart, vomiting or coughing.

The extent of the fistulous tract is clearly determined by injection of a radiopaque substance, such as lipiodol. The orifice may be closed to retain the oil by means of a purse string suture, local anesthesia being used in the skin about the external opening. Roentgen films will reveal both the extent and the course of the tract, in both the anteroposterior and lateral projections.

Treatment. — The most satisfactory treatment of a branchial fistula is complete excision of the fistulous tract.

Sclerosing solutions have been tried to obliterate the tract, with poor results.

All the methods of surgical excision described consist basically in removing the entire tract, from the external cutaneous opening up to the entrance of the fistulous tract into the pharyngeal wall. The internal opening may be demonstrated during the operation by injection of dye into the fistulous tract. Quite often, however, the use of dye is unsatisfactory, because it stains all the surrounding tissues when it escapes from the tract.

The surgical technic may vary, depending on the location of the tract, its extent and the presence or absence of an internal opening. When there is an internal opening, dissection of the tract to the pharynx with inversion of the upper end over a probe is advocated.

Sometimes a single transverse incision may prove adequate. Fistulas lying high in the neck can be adequately exposed by a lateral transverse incision at the level of the hyoid bone, which will provide good exposure of the region of the bifurcation of the carotid, where the inner portion of the fistulous tract plunges deep to reach the pharyngeal wall. On the other hand, a branchial fistula often has a very long course in the neck, with the outer orifice near the clavicle. A single incision to expose safely and dissect the tract would, of necessity, be long and quite disfiguring. A "stepladder" type of approach has been used in these cases: Two incisions are made. The lower incision is transverse, made in elliptic fashion about the orifice of the fistula and excising a small amount of the skin of the opening. Through this incision the fistula is dissected free upward toward the level of the hyoid bone. When that level is reached, a second transverse incision is made through the skin and platysma muscle and the dissected tract passed upward beneath the skin into the upper incision. The lower one can be sutured and a small drain inserted in the upper one at the conclusion of the dissection.

The upper half of the dissection demands special care and caution, because the tract passes upward to the pharynx between the internal and external carotid arteries, just above the exposed hypoglossal nerve, which crosses the external carotid artery and passes anteriorly to enter the submaxillary triangle of the neck.

Histologically, the fistulous tract is usually lined with squamous epithelium. Less frequently it may be lined with low columnar epithelium. Usually there is scattered

lymphoid tissue beneath the epithelium, occasionally with germinal centers.

According to Kinder,[15] a lateral cervical fistula is surrounded by a well-developed muscle sheath, which may originate either from the constrictor muscles of the pharynx or from the second branchial arch, or may develop from mesenchyma *in situ.*

Endotracheal anesthesia facilitates the surgical technic in all of the procedures.

Thyroglossal Cysts and Fistulas.—Lack of understanding of the embryonic development of the thyroid gland and improper surgical technic are widely recognized as the main causes of failure in treatment of *thyroglossal cysts and fistulae.*[16]

The thyroid gland has two anlagen. The lateral thyroid originates from the fourth branchial pouch; the median thyroid is from a diverticulum in the ventral wall of the pharynx between the tuberculum impar and the copula. Such a diverticulum appears at the end of the fourth week. The thyroid primordium grows caudally and by the fifth week appears as a bilobular structure connected to the pharynx by a stalk, the thyroglossal duct. This pedicle normally disappears by the sixth week, but a pit persists in the midline of the tongue to mark its point of origin, the foramen caecum.

The persistence of epithelial rests in the remnants of the thyroglossal duct results in thyroglossal cysts and fistulas.

Abnormalities of the thyroglossal tract appear as cysts or fistulas in the midline of the neck or at one side of the midline from the base of the tongue to the isthmus of the thyroid gland.

The cysts are often conspicuous in childhood but may assume significance in later life. The smooth, ovoid or round cystic mass moves on swallowing. It may remain dormant but frequently becomes infected and produces disfigurement. Usually it does not open to the surface of the skin unless it is ruptured or incised. Cysts in the suprahyoid area may cause choking sensation, dysphonia and dysphagia. The most common site is the midline, at the level of the hyoid bone. These cysts, however, occur above the body of the hyoid or may be located in the region of the isthmus of the thyroid gland.

The fistulas are congenital and appear as a cord of tissue palpable under the skin without evidence of a cyst. Sinus tracts may develop from a cyst previously lanced or incompletely removed, or one that has become infected.

Differential diagnosis includes dermoids, lipomas, sebaceous cysts, tumors of the thyroid gland and enlarged lymph nodes. Thyroglossal fistulas or sinuses should be differentiated from branchial fistulas. A roentgen study of the tract after injection of a contrast medium may be helpful.

Treatment.—Total extirpation of all epithelial bearing tissue is the only effective treatment of abnormalities of the thyroglossal tract.

Lancing the cyst, as well as incomplete removal, leads to recurrences and the development of a persistent draining sinus. The use of sclerosing solutions is ineffective and to be condemned. Irradiation is useless and dangerous, particularly in multiple small doses over a long period, as it may predispose to epithelial malignant change.

Radical excision is usually carried out by the technic of Sistrunk. A transverse incision is made over the cyst, or an elliptic transverse incision around the fistula opening. The dissection proceeds from the external opening upward to the pharynx.

The injection of dye, such as methylene blue, may sometimes be helpful in visualizing the tract, but most often it obscures the operative field.

In cysts and tracts located exclusively above the hyoid bone, the hyoid needs no

resection. However, when the tract extends beyond the level of the hyoid bone, the central portion of the hyoid is to be removed for complete excision of the tract. In order to locate all of the ramifications of the ducts, if present, it is best to open the cyst so as to identify the openings of the tracts. This has been most helpful.

Embryologic studies have shown that the thyroglossal duct may pass anterior to the hyoid, through the hyoid or, less often, posterior to the hyoid.

In following the tract to the foramen caecum it is often necessary to open the pharynx. This defect, however, is easily closed by a purse-string suture.

Histologically, thyroglossal tract cysts or fistulas are lined by the stratified, the squamous or the respiratory type of epithelium. A layer of fibrous connective tissue, of variable thickness, surrounds the tract. Lymphoid tissue is generally absent.

Thyroid tissue has been observed in a few cases. When the removal of a lingual thyroid or a thyroglossal cystic mass that may contain thyroid tissue is contemplated, a thyroid tracer study is in order to reveal the presence of the thyroid gland in the normal site.

SUMMARY

A classification of congenital cysts and fistulas of the head and neck is proposed on the basis of an embryologic-pathologic analysis. According to their origin from germ layers, they may be divided into ectodermal, entodermal and mesodermal.

An analysis of a personally observed group of congenital cysts and fistulas of the head and neck is made, including the embryologic aspects, clinical manifestations and therapeutic approach.

Dermoids of the nose are not "just pimples." Their embryonic origin is analyzed according to the morphogenesis of the nose as well as their localization in the midline from the glabella to the tip of the nose.

Preauricular sinuses and fistulas originate in the morphogenesis of the external ear and may be considered superiorly placed branchiogenic fistulas.

Branchiogenic cysts and fistulas develop during the morphogenesis of cervical structures of branchiogenic origin. The problems of differential diagnosis with other laterocervical masses and their complete surgical excision in relation to their topography are discussed in the light of the authors' personal experience.

Thyroglossal cysts and fistulas appear in the midline of the neck from the base of the tongue to the thyroid isthmus. Their close relation with the hyoid bone requires removal of the central portion of this bone for complete excision of the infrahyoid thyroglossal cysts and fistulas.

RESUMEN

Se propone una clasificación de los quistes y fístulas de cabeza y cuello basada en la embriología y la patología. Según la hoja plastodérmica de la cual derivan, tales procesos pueden ser ectodérmicos, endodérmicos y mesodérmicos.

Se analiza un grupo de casos personales de sujetos con quistes y fístulas de cabeza y cuello observándoles tambien bajo el punto de vista de la embriología las manifestaciones clínicas y la orientación terapéutica.

Los quistes dermoides de la nariz no son "solo granos." Se estudia su origen relacionándolo con la morfogenesis de la nariz y con su localización en la misma.

Los senos y fístulas preauriculares se forman durante el desarrollo de senos de la cabeza de origen bronquial.

Se estudian los problemas que plantean por un lado el diangóstico diferencial de estos procesos con otros que asienten en las regiones laterales de la cabeza y el cuello, y por otro la extirpación quirúrgica de los mismo en relación con la anatomía topográfica; el autor se apoya en su experiencia personal para presentar este estudio.

Los quistes y fístulas del conducto tirogloso aparecen en la línea media del cuello desde la base de la lengua hasta el istmo del tiroides; su proximidad al hueso hioides requiere una extirpación radical.

RÉSUMÉ

L'auteur propose une classification de kystes et fistules congénitaux de la tête et du cou, basée sur l'analyse embroyologique-pathologique; suivant l'origine des feuillets blastodermiques ils peuvent être divisés en: ectodermiques, endodermiques et mésodermiques.

Un groupe observé personnellement est étudié, décrivant les aspects embryologiques et les symptômes cliniques, ainsi que la thérapeutique.

Les dermoïdes du nez ne sont pas de simples "boutons." Leur origine embryologique est analysée par rapport à la morphogénèse du nez et à leur localisation au milieu de la ligne située entre la glabelle et le bout du nez.

Les sinus et les fistules pré-auriculaires ont leur point de départ dans la morphogénèse des structures cervicales d'origine branchiogène. Ces problèmes de diagnostic différentiel avec d'autres formations latérocervicales, et leur excision chirurgical radicale par rapport avec leur tpographie, sont discutés à la lumière d'expériences personnelles.

Les kystes et fistules thyréoglosses apparaissent dans la ligne médiane du cou, de la base de la langue à l'isthme thyroïdien. Leur relation étroite avec l'os hyoïde exige leur ablation.

RIASSUNTO

Viene proposta una classificazione delle cisti e delle fistole congenite del capo e del collo, basata su criterii embriologici. A seconda della loro origine dai varii foglietti, esse possono essere distinte in ecto-, endo-, e mesodermiche. Viene presentata una statistica personale di casi curati chirurgicamente.

Viene esaminata l'origine embriologica delle cisti dermoidi del naso in rapporto alla loro sede sulla linea mediana, dalla glabella alla punta.

Le fistole e cisti pre-auricolari si originano durante la morfogenesi delle strutture cervicali che derivano dagli archi branchiali. Vengono discussi i problemi della diagnosi differenziale con le altre tumefazioni latero-cervicali e della loro asportazione chirurgica radicale.

Le cisti e fistole del dotto tireo-glosso si manifestano sulla linea mediana del collo, dalla base della lingua all'istmo della tiroide; il loro stretto rapporto con l'osso joide impone l'asportazione della porzione centrale dell'osso stesso.

SUMARIO

Propõe uma classificação das fistulas congenitas e cistos da cabeça e do pescoço com base embrio-patologica. De acordo com a origem das camadas germinativas divide-os em: ectodermicos, mesodermicos e endodermicos. Faz uma añalise pessoal dos grupos dessas molestias e nela inclue os aspectos em briologicos, as manifestações clínicas e a terapêutica.

A origem embrologica dos cistos dermoides do nariz é revista de acordo com a morfogênese do orgão bem como estuda sua localização mediana, da glabela á ponta.

Os trajetos e fistulas pre-auriculares que se originam na morfogênese das estrutaras cervicais de origem bronquiogênica são estudados pelo A. Discute e emite

observaç oes pessoais sôbre os problemas de diagnostico diferencial com outras formações tumorais latero-cervicais e aprecia a excisão cirurgica de conformidade com a situação topográfica.

Os cistos e fístulas do tireoglosso surgem na linha média do pescoço da base da lingua ao ístmo da tireóide.

A aderência com o ôsso hióide requer excisão do tireoglosso central com o cisto e a fistula.

ZUSAMMENFASSUNG

Es wird eine Einteilung der angeborenen Zysten und Fisteln des Kopfes und des Halses auf embryologisch-pathologischer Basis vorgeschlagen. Je nach der Keimschicht, von der sie entspringen, können sie als ektodermal, endodermal und mesodermal klassifiziert werden.

Der Verfasser berichtet über sein Studium einer von ihm persönlich beobachteten Gruppe von angeborenen Zysten und Fisteln des Kopfes und des Halses einschliesslich ihrer embryologischen Eigenheiten, des klinischen Bildes und des therapeutischen Vorgehens.

Dermoidzysten der Nase sind nicht "einfache Pickel." Ihr embryologischer Ursprung wird auf Grund der Gestaltbildung der Nase und auf Grund ihres Sitzes in der Mittellinie zwischen der Glabella und der Nasenspitze untersucht.

Präaurikuläre Fistelgänge entstehen während des Wachstums der aus den Kiemenspalten stammenden Gebilde des Halses. Das Problem ihrer differentialdiagnostischen Abgrenzung von anderen Geschwülsten im seitlichen Halsabschnitt und ihre völlige chirurgische Entfernung unter Berücksichtigung der Topographie werden auf Grund der persönlichen Erfahrungen des Verfassers erörtert.

Zysten und Fisteln des Ductus thyreoglossus treten in der Mittellinie des Halses zwischen dem Zungengrund und dem Isthmus der Schilddrüse auf. Diese zentralen Zysten und Fisteln erfordern Resektion wegen ihrer engen Beziehung zum Zungenbein.

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Proctologic Surgery

Acute Rectal Herniation of the Omentum

Report of a Case

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THE case here reported is so unusual that I have failed to encounter a similar one in the literature. It is for this reason that it is now being reported, with a discussion of the probable etiologic factors.

REPORT OF CASE

C. S., a girl aged 5 years and 11 months, was admitted to my service of Christ Hospital on Aug. 15, 1952. The child, well developed and normal in every respect, had an essentially normal past history except that at the age of 6 months she was treated in Italy for "visceral fever" (enteritisá), from which she promptly recovered.

The present illness originated while she was playing with her 1-year-old sister, who pushed her, causing her to trip over the toys and fall on the floor. She immediately complained of pain in the stomach and a desire to move her bowels. The mother noticed that the stool was spotted with blood and, in cleaning her afterward, noticed a piece of fleshy material extruding from the anus. The family physician was summoned, and the child was admitted to the hospital about 1 p.m. with a presumptive diagnosis of rectal polyp. At this time she was perfectly at ease and had no complaints. The resident, Dr. M. DaSylva, in examining the child and wiping the anus clean with saline solution, expressed the opinion that the supposed polyp resembled omental tissue and recorded this as her impression.

As I was not available, my assistant, Dr. S. Detrano, was notified. He examined the child proctoscopically at about 4 p.m. and at this time was unable to identify properly the nature of the extruding mass. It was dark, with a broad base, and was not characteristic of polyp, omentum or rectal mucosa. At about 6 p.m. I was appraised of the foregoing facts and was also told that the child had begun to complain of pain in the right side of the abdomen and that a sensation of muscular defense was being elicited. Laboratory data were essentially normal. The patient was therefore scheduled for operation that evening.

In the operating room, a digital rectal examination revealed a long polyp-like structure arising about 4 inches (10 cm.) from the anterior wall of the rectum, with a broad base. Nevertheless the impression was not that of a polyp. At the same time, I was unable to agree with the resident's impression at the time of her examination. The trauma sustained certainly was minimal for rectal perforation. By this time the lower part of the abdomen was definitely tender and moderately rigid.

It was decided to explore the rectum, with the aid of anesthesia, before proceeding with the laparotomy. When the rectum was viewed through the anoscope, it was evident that the lesion under consideration was not a polyp. At its base was a ringlike defect in the anterior rectal wall, to which the particular fleshy structure either passed through or was attached to. Gentle traction was applied, and it was then that at one point the structure yielded a little and the omental characteristics of the mass clearly seen.

The child was therefore turned on her back, and a laparotomy was performed.

How, then, can one explain the events in this particular case?

In order to understand the pathogenesis

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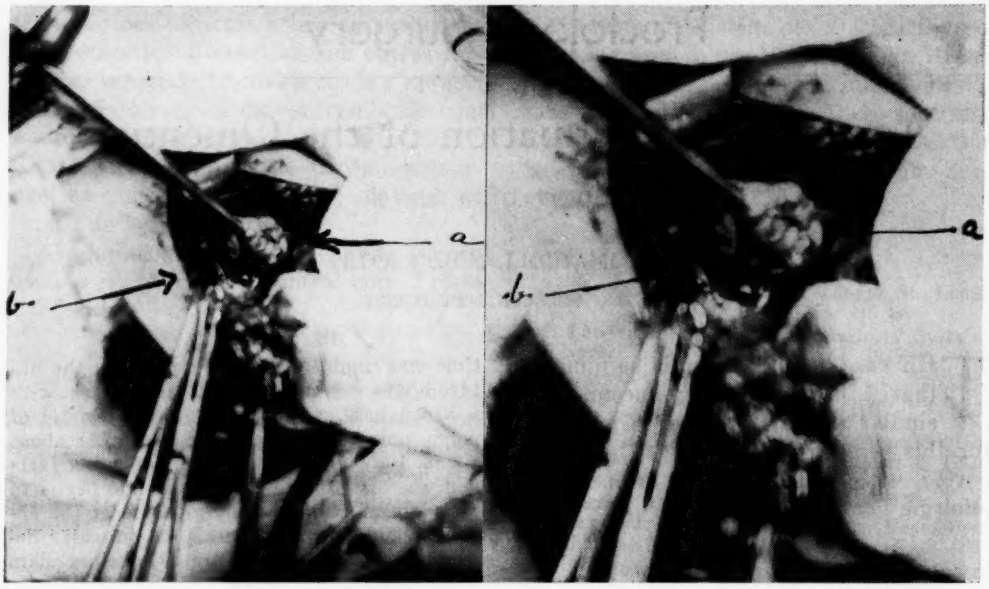

Fig. 1.—Two photographs showing transected omentum (*a*) and hernial ring (*b*).

of anorectal anomalies, one must bear in mind the embryonic development of the abdominal perineal structures.

In the 5-week embryo, the allantoic and the wolffian ducts join to form the urogenital sinus. This communicates posteriorly with the hindgut to form the cloaca. Between the fifth and the eighth week a progressive cleavage occurs between the urogenital system and the lower part of the intestine, so that by the end of this time each of these systems has acquired a separate external opening. It is therefore easily understandable how any arrest or abnormality of development during this period can lead to anomalous connections between the rectum and the urogenital tract, such as rectovesical, rectourethral, rectovaginal and even rectouterine fistulas.

In this particular case it is my opinion that a fistulous tract, probably between the rectum and the vagina anteriorly, had begun but that it did not go on to completion. Henee there was an annular defect in the anterior part of the rectum, to the peritoneal side of which the omentum has become firmly attached (note pathologic report). Whether this rectal defect was also lined with peritoneum on one side and rectal mucosa on the other is conjectural. Certain it is, therefore, that, although the child had no ill effects from this defect for five years, the sudden increase in intra-abdominal pressure caused by the unexpected fall was sufficient to

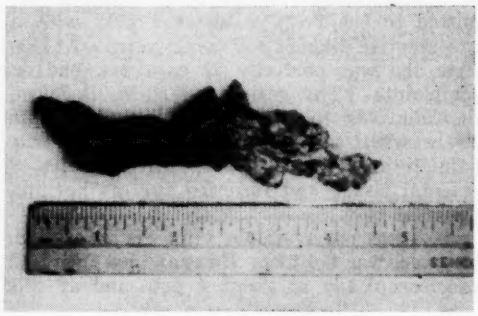

Fig. 2.—Gross specimen.

propel the attached omentum through and into the rectum, much in the manner of the formation of traumatic diaphragmatic hernia except that the cause of the latter is the severe trauma rather than the existence of a congenital defect.

The low midline incision revealed the rectally observed ring just above the peritoneal reflection on the anterior aspect of the rectum (Fig. 1). There was no evidence whatever of trauma about this opening, and one had the impression that it was a congenital defect much like a hernial ring. There was no other pathologic feature, except that the omentum had herniated through the rectum and out of the anus (Fig. 2). The omentum was transected; the distal portion was removed through the rectum, and the rectal fistula was closed with No. 00 chrome and reinforced with a row of interrupted Pagenstecker sutures. The child made a smooth and uneventful recovery and was discharged on the sixth postoperative day.

Pathologic Report.—Gross:

The omental tissue measured 9 cm. in length, 5 cm. in width at its base and 5 mm. in thickness. Two cm. from the base there was a constriction beyond which the tissue was dull firm gray-red. On section it was granular and yellow-red. Near the base the tissue was yellow and greasy.

Diagnosis: Omental fat showing early hemorrhagic infarction, acute phlegmonous inflammation and a *small group of glands suggestive of embryonal rest.*

COMMENT

It must be admitted that this was an acute episode; yet the fall sustained was not severe enough to cause perforation of the rectum. At the same time, the perforation noted bore no marks whatever of trauma, and its smooth margin had all the characteristics of a congenital defect.

SUMMARY

A case of acute herniation of the omentum through a congenital defect in the rectum in a child 5 years old is reported. It has not been possible for the author to find a comparable case reported in the literature.

RÉSUMÉ

Un cas d'épiplocèle aiguë par malformation congénitale du rectum chez un enfant de 5 ans est décrit. L'auteur n'a trouvé aucun cas similaire dans la littérature.

SUMARIO

Relata um caso de hernia do epiplon atraves defeito congenito do reto em uma criança de cinco anos de idade. Não foi possivel, diz o A. encontrar caso idêntico na literatura.

RIASSUNTO

Viene riferita un'ernia acuta di omento attraverso un pertugio nel muscolo retto in un bambino di 5 anni. L'autore non ha trovato casi analoghi nella letteratura.

ZUSAMMENFASSUNG

Es wird über einen Fall akuter Herniierung des Omentums durch einen angeborenen Defekt im Mastdarm bei einem fünfjährigen Kinde berichtet. Der Verfasser konnte in der Literatur keinen Bericht über einen ähnlichen Fall finden.

RESUMEN

Se refiere un caso de hernia aguda del omento a través de un defecto congénito en el recto de un niño de cinco años.

El autor no ha logrado encontrar un caso semejante en la literatura revisada.

Sección en Español

Efecto de las Malformaciones Arteriovenosas del Cerebro Sobre los Vasos del Encefalo

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SI bien es cierto que la importancia de las malformaciones cerebrales arterio-venosas es ampliamente reconocida y que los problemas relativos a su diagnóstico y tratamiento han sido extensamente discutidos en la literatura de los últimos treinta años, existen aún sin precisar algunos problemas fisiopatológicos de estas malformaciones, tales como los efectos que ejercen sobre las otras arterias y venas del cerebro, la consecuente alteración de la hemodinámica cerebral y su efecto sobre la circulación sistémica.

Con objeto de obtener información relativa a estos problemas se efectuó un estudio de 102 casos de angiomas cerebrales demonstrados en el Lysholm Department del National Hospital (Queen Square)* entre 1946 y 1956, habiéndose dedicado especial atención a la evidencia angiográfica y a, los cambios radiológicos presentes después de la extirpación parcial o total de estas anomalías vasculares (Casos operados por el Dr. Wylie McKissock).

Resultados.—La distribución en los sexos de los 102 casos fué de 52 masculinos y 50 femeninos y las malformaciones se encontraron situadas en el lado derecho en 50 casos y en el izquierdo en 52. Se encontraron calcificaciones de tamaño variable en 17 casos (16%) y casi siempre sobre la región del angioma.

Los principales vasos alimentadores de las malformaciones fueron la arteria cerebral media en 61 casos (60%), la cerebral anterior en 12 (11%), la cerebral media y anterior en 11 (10%) y ambas cerebrales anteriores en 2 (1.9%).

De los 61 casos con angioma en el territorio de la cerebral media, 42 (69%) no mostraron llenado de la cerebral anterior y en 9 (14.5%) el contraste fué visible en dicha arteria pero con poca claridad. Uno de los 12 casos de angioma en el territorio de la cerebral anterior mostró falta de llenado de la cerebral media.

De los 102 casos de este serie, 95 (93%) tenían dilatación de una o varias aretrias cerebrales y en la mayoría de ellos el calibre de la arteria aferente o alimentadora fué considerado como aumentado sobre la base de la comparación con la arteria correspondiente del otro lado o con otros arteriogramas normales.

El estudio comparativo de las arteriografías pre y post-operatorias de los 15 casos operados reveló una apreciable reducción del calibre de las arterias aferentes en 13 casos (86%) y reducción o desaparición de las venas dilatadas en 10 casos. La cerebral anterior se encontró ausente o contrastada débilmente en 8 de 15 casos (53%) antes de la operación y pobremente visusalizada en uno; de aquellos ocho

**Neurologo del Hospital Central SCOP.

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casos, la arteriografía post-operatoria mostró un perfecto llenado de la arteria y de sus ramas más periféricas en 5 casos; los tres restantes en los que la cerebral anterior permaneció sin llenarse fueron aquellos cuya extirpación fué superficial quedando intacta la mayor parte del angioma.

DISCUSION

Aunque es bien sabido que la velocidad circulatoria está francamente aumentada enestos casos de malformaciones cerebrales arterio venosas, la confirmación de este hecho hecho en términos de hemodinámica y con datos cuantitativos no apareció hasta 1948 cuando Shenkin, Spitz, Grant y Kety demonstraron en dos de estos casos un aumento del flujo cerebral en tres veces su valor normal, un aumento del gastro cardíaco y una discreta reducción de la presión arterial media. En ambos casos los autores encontraron cardiomegalia y en uno de ellos se demostró electrocardiograficamente anormalidad miocárdica. Estos autores han propuesto como explicación del aumento del gasto cardíaco, una acción refleja por descenso de la presión arterial en las zonas reflexogénicas aórtica y carotídea como consecuencia de la disminución de la resistencia periférica. Bernsmeier y Siemons (1953) encontraron en seis casos de angiomas un aumento del flujo circulatorio cerebral de 80 a 200 cc/100 gm/min, una disminución de la diferencia de oxígeno arteriovenoso de entre 1.4 a 4.3 vol %, un aumento de la presión venosa de entre 6 a 10 mm y una reducción de la resistencia periférica de entre .5 a 1.2. Tönnis y Lange-Cossack encontraron la normalización del flujo circulatorio cerebral en 5 casos después de la extirpación quirúrgica de angiomas.

La evidencia obtenida en este estudio demuestra claramente que la presencia de una malformación cerebral arteriovenosa determina una dilatación de las arterias alimentadoras del angioma y del los troncos arteriales correspondientes en el cuello y tan cereca del corazón como la carótida primitiva y la vertebral. Es también bastante evidente que este cambio estructural es relativamente reversible cuando la causa primaria es eliminada y parece razonable inferir que la explicación de esta dilatación sea el aumento del volumen de sangre que pasa por esas arterias hacia el angioma, el cual constituye un punto de resistencia periférica considerablemente disminuída.

Desde el punto de vista de la distribución de la sangre a los diferentes territorios de las arterias cerebrales, la presencia de una angioma cerebral deriva hacia el sitio de su implantación una cantidad considerable de sangre desde otras regiones del cerebro, especialmente del territorio de la cerebral anterior en los casos alimentados por la cerebral media que son los más frecuentes. La falta de llenado de la carebral anterior y sus aspecto después de la operación así como el llenado de la fase capilar fueron considerados como evidencia aceptable del efecto que ejercen estas anomalías sobre el resto de la circulación cerebral.

A pesar de las afirmaciones de otros autores en el sentido de que estas malformaciones no tiene repercusiones cardíacas, el hecho de que se haya encontrado cardiomegalia en los dos casos de Shenkin et al. y en el caso de Rosenberg (1952) con aumento del gasto cardíaco a 7.21/min y el hecho de que las arterias en el cuello hayan sido encontradas con dilatción en los casos de autopsia por Cushing y Bailey (1927) y de que se demuestren arteriográficamente estos cambios en esta serie, sugieren que las malformaciones AV cerebrales deben tener sobre el corazón mismo una mayor repercusión que la que nos es permitido suponer por los demasiado escasos estudios cardiovasculares de estos enfermos.

Siendo la normalización del calibre de las arterias cerebrales dilatadas tan impresionante después de la operación, parece razonable aceptar el carácter relativamente benigno de estas anomalías con relación a sus efectos sobre otros vasos y tal vez sobre la circulación general.

Uno de los problemas intersantes de estas malformaciones es la lenta evolución de un proceso considerado congénito y que habitualmente empieza a dar síntomas después de dos o tres décadas. Este hecho sugiere que estos angiomas son relativamente pequeños al nacer sus portadores y que sólo con el tiempo se convierten y producen las enormes dilataciones vasculares que se observan frecuentemente y quizas estas últimas son consideradas erróneamente como parte integrante del angioma y no como una consecuencia del mismo. Así como estas dilataciones vasculares son reducidas por la extirpación del angioma, es razonable el considerarlas susceptibles de aumentar su tamaño; esto es apoyado por una observación de Olivecrona (1948) de un caso en que la angiografía demostró un aumento considerable del tamaño de los vasos anormales después de un intervalo de diez años.

La dilatación de las arterias en el cuello alcanza a veces un calibre tan grande que nos sería sorprendente encontrar agrandamiento de los conducto óseos atravesados por estas arterias en las vértebras cervicales o en el cráneo. Aunque el material necrópsico no es lo suficientemente abundante como para confirmar la existencia de agujeros vertebrales o canal carotídeo agrandadoo, Blackwood ha encontrado en uno de los casos de esta serie un aumento del agujero rasgado posterior. Lindblom (1936) ha encontrado un agrandamiento del agujero redondo menor en 12 casos de malformaciones AV y Hoare (1953) considera el aumento de tamaño de los agujeros vertebrales como evidencia radiológica de angiomas de la fosa posterior.

Naturalmente que los datos radiológicos no permiten decidir sobre la naturaleza histológica de los cambios de calibre de las arterias aferentes encontrados en estos casos, en el sentido de que correspondan a una hipertrofia de la pared arterial o solamente a dilatación de la misma. La revisión de la literatura no produjo suficiente información histopatológica para contestar esta pregunta aunque tal vez parezca más factible suponer una dilatación pasiva de la pared arterial debida al aumento del volumen sanguíneo.

CONCLUSIONES

Las malformaciones cerebrales arteriovenosas estudiadas en esta serie producen, según la evidencia presentada, una dilatación secundaria de la arteria alimentadora y de otras arterias más proximales y tan cerca del corazón como la carótida primitiva y la vertebral. Las venas que drenanla región correspondiente al angioma también se encontraron dilatadas muy frecuentemente. La dilatación de la arteria alimentadora está asociada a una reducción de calibre de las arterias que irrigan territorios cerebrales adyacentes y en un número considerable de casos a una falta de llenado de estos vasos.

Se han considerado estas alteraciones radiológicas de la circulación cerebral como una consecuencia directa de la presencia del angioma, ya que el aspecto de aquellos vasos se normalizó después de la excisión de la malformación. Para precisar y valorar la repercusión de estas malformaciones vasculares sobre el corazón y la circulación general será necesario un número mayor de estudios cardiovasculares en estos enfermos.

SUMARIO

Se realizó estudio de 102 arteriografías de casos con malformaciones cerebrales arteriovenosas con objeto de valorar la

influencia que estas anomalías pudieran tenor sobre la circulación cerebral, haciendo un análisis de los cambios radiológicos ocurridos después de la extirpación quirúrgica de 15 de estos casos. Se encontró constantemente una dilatación de la arteria alimentadora y de las arterias que irrigan territorios adyacentes así como de la carótida primitiva y de la vertebral. Esta dilatación secundaria desapareció después de la extispación del angioma y se apreció un marcado mejoramiento de la circulación en arterias previamente ausentes en la arteriografía, especialmente en la cerebral anterior cuando el angioma estaba situado en el territorio de la cerebral media.

SUMMARY

A study of 102 arteriograms taken in cases of cerebral arteriovenous malformation was carried out to assess the influence of these anomalies upon the rest of the cerebral circulation, with analysis of the radiologic changes occurring after surgical extirpation in 15 of those cases. The afferent artery was constantly observed to be dilated, as well as the arteries feeding adjacent territories, and even the common carotid and the vertebral arteries. This secondary arterial dilatation disappeared after removal of the angioma, and a marked improvement of circulation was noted in previously unfilled arteries, especially when the angioma was in the territory of the middle cerebral artery.

RÈSUMÈ

Une étude de 102 artériogrammes—cas d'affections artérioveineuses cérébrales—a été faite en vue d'établir l'influence de ces affections sur la circulation cérébrale, avec analyse des modifications radiologiques après extirpation chirurgicale dans 15 cas. L'artère afférente est toujours apparue dilatée, de même que les artères alimentant les régions adjacentes, y compris la carotide primitive et les artères vertébrales. Cette dilatation artérielle secondaire a disparu après extirpation de l'angiome; on a noté également une amélioration nette de la circulation d'artères qui, antériuerement, ne se remplissaient pas, surtout lorsque l'angiome était situé dans le territoire de l'artère cérébrale moyenne.

RIASSUNTO

E' stato eseguito uno studio su 102 arteriogrammi relativi a malformazioni arterovenose cerebrali onde stabilire l'influenza di tali malformazioni sul resto del circolo cerebrale. In 15 di questi casi si studiarono anche le modificazioni radiologiche indotte dall'asportazione chirurgica della lesione. L'arteria afferente era sempre dilatata, come pure le arterie tributarie dei territori vicini, la carotide comune e le vertebrali. Questa dilatazione secondaria delle arterie scompare dopo la asportazione dell'angioma, mentre si nota uno spiccato miglioramento del circolo arterioso e il riempimento di arterie prima vuote, specialmente in caso di angiomi del territorio della cerebrale media.

ZUSAMMENFASSUNG

Es wurde eine Untersuchung von 102 Arteriogrammen in Fällen von arteriovenösen Missbildungen der Hirngefässe ausgeführt, um den Einfluss dieser Anomalien auf den übrigen Hirnkreislauf abzuschätzen; in 15 von diesen Fällen wurden die nach chirurgischer Resektion auftretenden röntgenologischen Veränderungen studiert. Es liess sich ständig eine Erweiterung der zuführenden Arterie, aber auch der Schlagadern, die die angrenzenden Gebiete versorgten, und sogar der Carotis communis und der Wirbelarterien beobachten. Diese sekundäre Schlagadererweiterung verschwand nach Entfernung des Angioms, und eine erhebliche Verbes-

serung des Kreislaufs liess sich in vorher nicht gefüllten Arterien feststellen, besonders wenn das Angiom im Gebiet der mittleren Hirnarterie lag.

SUMARIO

O A. apresenta uma analise de 102 arteriogramas cerebrais com malformações arterio venosas de modo a investigar a influencia dessa anomalias sôbre o resto do cérebro, incluindo um estudo das modificações registradas na radiologia apos a excisão cirurgica em 15 casos. Foi constantemente observada a dilatação da arteria aferente assim como as dilatações das arterias do territorio adjacente e mesmo da carotida primitiva e das arterias vertebrais poude ser constatadas. Essa dilatação secundaria desapareceu após a excisão do angioma notando-se acentuada melhoria circulatoria especialmente quando o angioma estava localizado no territorio da arteria cerebral média.

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Chadwick was the originator of a well-known argument which we heard frequently before the second World War, but which has temporarily lost its validity—that the cost of armaments and military preparations, if translated into sanitation, would bring large dividends. We hear often that a particular health improvement would be less than "the cost of a battleship." Chadwick used that same illustration a hundred years ago. Health versus war was his swelling theme as he contrasted the large armies of the old Russia and the Bourbon Italy with the backward state of their sanitation, and he declared that the cost of one English battleship (in those happy days only one million pounds) would purchase a sewage scheme for over a quarter of a million people, and would save each year 1667 lives.

—*Williams*

Editorial

The Evolution of Physiology*

THE word "physiology" as the description of a particular biological and medical discipline appears to have been first employed in the sixteenth century by Jean Fernel, a member of the faculty of medicine in Paris. Fernel applied the term to what in the medical terminology of that period was called "natural things," that is, to the functioning of the body in a state of health, and identified Aristotle as the founder of the subject.[1]

If then we look back to classical antiquity, we find that physiology was based on the theory of the humors, a theory maintained down to the seventeenth century but which was first clearly enunciated in the Hippocratic treatise *On the Nature of Man.* According to this theory, there were four humors in the body, called blood, black bile, yellow bile and phlegm. These humors represented the four fundamental bodily liquids, and health depended upon their equilibrium; otherwise illness might result from the too sanguine condition of an excess of blood the melancholy associated with excessive black bile, the bilious condition of an excess of yellow bile, or a phlegmatic state.

Blood, however, was important not only as a humor but as the vehicle that carried the other humors, so that an imbalance of humors, that is, an excess of one of them, might under certain conditions be alleviated by bloodletting, by which the excessive humor could be drained off. Furthermore, the body's nourishment was distributed to the tissues through the medium of the blood, and the body's spirits were manufactured and distributed with its aid. As a result, the factors of nutrition, respiration and indirectly even muscular action were for many centuries identified with and subordinated to the question of the blood's production and movement. It is necessary first, therefore, to trace the evolution of ideas on the movement of the blood and, incidental to this, those other and related phenomena.

The first notable student of the subject, as Fernel indicated, was Aristotle[2] (384-322 B.C.), who considered the heart the center of the vascular system, the first organ to be developed and the last to die, as well as the center of intelligence and sensation. According to Aristotle, the heart was the source of the body's vital heat, necessary for life; while the heart contained no auricles, in larger animals, including man, it possessed three ventricles.

Aristotle made no distinction between blood vessels and considered the heart and vessels merely containers for the blood. There was no movement of the blood in the vessels, but rather a movement of material through the blood for nourishment of the tissues and for renewal of the blood's nutritional ingredients.

The blood was renewed by nourishment absorbed from the alimentary canal by way of the mesenteric vessels. This nutriment altered the blood's condition as it

*Lecture given at the International Surgeons' Hall of Fame in December 1957, in the series offered by the School of the History of Surgery and Allied Sciences of the International College of Surgeons.

1. *De naturali parte medicinae*, Paris, 1542, II, "praefatio." This appears somewhat revised in Fernel's *Medicina* of 1554, at that time clearly under the title of *Physiologiae lib.* VII; cf. Sherrington, *The Endeavour of Jean Fernel*, Cambridge, 1946, pp. 60 ff., 182, 189-90, 194.

2. Aristotle's ideas on the subject are to be found especially in his *Parts of animals*, II, iii, III, iii-vi, *Account of animals*, I, xvii, *On generation*, II, iv, *On respiration*, v, vi, xiv, *On the spirit.*

advanced through the blood until finally such alteration reached the heart itself. Hence it was not the blood that moved, but its quality that was gradually changed.

According to Aristotle, inspired air passed into the lungs, whence it moved onward through the pulmonary artery and pulmonary vein into the heart; along its course this air was altered into a spirituous substance called pneuma, which tempered the heat of the heart and contributed the final quality necessary for the perfection of the blood. Furthermore, according to Aristotle, the innate heat of the heart, the vital principle, was necessary for the final perfection of the blood, and in the course of this final perfection a kind of boiling was produced in the blood, leading to the simultaneous expansion of the heart and vessels and so producing the pulse. Expiration carried off the excess heat of the heart and the fumes created in the final cooking of the blood.

At approximately the same time Praxagoras of Cos, known today only indirectly through the writings of others, made two further observations, one correct and the other incorrect. First, he related pulsation only to the arterial system; second, he asserted that the arteries contained solely that spirituous substance called pneuma, while all blood was either in the heart or in the veins.[3]

In the third century B.C., further investigation and some advancement in knowledge were provided by the post-Aristotelian school of Alexandria, where for the first time human dissection and animal vivisection were practiced. Two investigators in particular are worthy of note, Herophilus and Erasistratus. Herophilus of Chalcedon,[4] like Praxagoras, distinguished between veins and arteries; also, he was the first to count the pulse and to note variations in it with the aid of a water-clock or clepsydra. Furthermore, he declared the brain to be the seat of intelligence and sensation, thus reversing the older opinion of Aristotle, and he described the nerves as concerned with motion and sensation.

The second and slightly younger Alexandrian investigator, Erasistratus of Chios,[5] sometimes called the father of physiology, by building upon the work of his predecessor and carrying on considerable animal experimentation, acquired further knowledge of the heart, and described the cardiac valves. According to Erasistratus, in diastole the heart expanded like a bellows and blood was drawn into the right ventricle, whence it passed on to the lung for its nourishment. At the same time pneuma was drawn into the left ventricle and onward into the arteries. Erasistratus recognized the fact that blood could pass from pulmonary artery to vein, but only in a morbid condition, when too much blood had led to rupture and a forced passage, an indication of this being fever or inflammation. Erasistratus also distinguished between motor and sensory nerves, ascribed the higher intelligence of man to a greater elaboration of the cerebral convolutions and made a crude beginning in the study of metabolism.

Despite their contributions of fact, the Alexandrians, especially Erasistratus, bequeathed later generations one decidedly detrimental theory that was to remain an obstacle for almost two thousand years. According to this theory, every organ contained three kinds of tubes: veins, arteries and hollow nerves, in which were to

3. Galen, *On tremor, palpitation, convulsion and rigor, v. Whether or not blood is contained in the arteries,* viii. In the standard edition of Galen's works, edited by C. G. Kuhn, these are to be found in vols. VII, p. 598, and IV, p. 731 ff.

4. J. F. Dobson, "Herophilus of Alexandria," *Proc. Roy. Soc. Med.* 18:1924-25, pt. 2, "Sect. Hist. Med.," pp. 19-32. While this collection of extracts from Galen's writings regarding Herophilus, as well as the collection on Erasistratus, is very useful, it must be employed with some caution, since it is not as complete as the reader may assume and not wholly free from error arisen from the removal of passages from their contexts.

5. J. F. Dobson, "Erasistratus," *loc. cit.*, 1927, 20: pt. 2, pp. 825-32.

be found blood and two kinds of pneuma. When inspired air passed from the lungs into the left ventricle of the heart, it was changed into that form of pneuma called vital spirit, which was distributed throughout the body by way of the arteries and provided stimulus or vitality for the functioning of the organs. It was the source of the pulse and the body's innate heat, and as a consequence vital spirit was considered the active force causing digestion, nutrition and assimilation. Some of the vital spirit, however, was carried to the brain, where it was further elaborated into a second pneuma called animal spirit which was distributed throughout the body by way of the nerves which were considered to be hollow. This animal spirit was related to sensation and was the force causing consciousness and muscular action.

In the second century A.D., the great Greco-Roman physician Galen (130-200) corrected that doctrine of Praxagoras and the Alexandrians by which the arteries had been considered to contain a pneumatic spirit rather than blood. The veins, wrote Galen, contained a darker blood, owing to the nutritive material carried in it, while the blood of the arteries was lighter, hotter and more spirituous. Furthermore, in opposing the Aristotelian conception of the heart as the center of sensation, Galen also reduced the number of ventricles in the human heart to two and found the origin of the venous system in the liver.

According to Galen, the nutritive portions of food were drawn from the intestines as chyle; carried to the liver by the portal vein, this chyle was elaborated into blood and charged with a new essence called natural spirit. From the liver the blood was distributed throughout the body to give off nourishment and to absorb impurities. Some of the blood eventually reached the right ventricle of the heart, where it might then follow one of several courses. First, the major portion, having given off its impurities, flowed back into the venous system; second, a lesser portion, likewise purified, passed from the right ventricle into the left through pores in the cardiac septum. The fact that these pores had never been observed in a dead body, even by Galen, was considered due to shrinkage, which rendered them invisible. A third small portion of the blood was carried to the lungs by way of the pulmonary artery. There the impurities were given off through the trachea, and the blood itself ultimately passed into the pulmonary vein and so onward into the left ventricle. Here, of course, was a germ, long to remain undeveloped, of the pulmonary circulation. Once the blood arrived in the left ventricle it was charged with the second or vital spirit, and such vital spirits as were carried in the blood to the brain were further elaborated into animal spirits in the *rete mirabile*. The *rete mirabile*, or marvelous network of arteries, found in ungulates but not in man, nevertheless continued to be accepted on the basis of Galenic tradition as late as the sixteenth century.

The pulmonary vein was also the passage by which air, transformed into pneuma, was carried into the left ventricle, and by the reverse route the hot vapors resultant from the perfection of the blood were carried out. Galen seemed undisturbed by the fact that according to his scheme two different substances must occupy the pulmonary vein at the same time, but presumably the small amount of blood in movement, according to his idea, helped explain away this obstacle.

Galen appears to have recognized some movement of the blood, although a very slow one, as new blood was formed in the liver to replace that which had been consumed in the course of nourishment of bodily tissues. He considered the move-

ment, however, one of attraction rather than of propulsion, produced by a force which he imagined to reside in fibers in the heart and vessels. The pulse of the arteries indicated not movement but merely a pulsatile force existing in the walls of the vessels.[6]

Galen's views on the operation of the cardiovascular system are best presented in his book entitled *On the Use of the Parts,* which is sometimes referred to as the first textbook of physiology, while its author is sometimes given that title, "father of physiology," which has also been bestowed occasionally upon Erasistratus. Galen performed large numbers of experiments on animals and was the first to investigate disorders in the normal structure and function as a means of explaining pathologic conditions; altogether he succeeded in making a certain number of contributions to physiology. In addition to his views on the functions of the cardiovascular system, mention may be made of his demonstration that although longitudinal section of the spinal cord did not produce muscular paralysis, transverse section caused loss of sensation and muscular paralysis below the section, and semisection caused muscular paralysis only on the side sectioned. By ligation of the recurrent laryngeal nerve he demonstrated its function in regard to voice production. The function of the phrenic nerve was also known to him, and he was aware that respiration required the use of the thoracic muscles as well as the diaphragm.[7] Moreover, in addition to whatever he himself accomplished, Galen is owed a debt for gathering into his writings the opinions and statements of his predecessors, which otherwise would have been completely lost to us.

While Galen's writings are a repository of the physiologic knowledge of classical antiquity, they are also the last such body of writings for more than a millenium that demonstrate progressive views. With the passing of classic civilization the culture of the western world declined; so far, indeed, that not only were no advances made in the knowledge of physiology, but there was considerable retrogression from the position that had been reached by the classic physicians. Therefore we shall pass over this dismal picture and move on to the period of renewed scientific development.[8]

Western development of scientific anatomy and physiology was reestablished in the course of the sixteenth century, but only after a bitter struggle with the restrictive authority of the past. Moreover, such development of knowledge of physiology was chiefly confined to the study of the function of the cardiovascular system. While in the course of the sixteenth century the recovered writings of Greek and Hellenic physicians were to exert a direct influence upon medicine, immediately upon the opening of that century the major influence was Moslem, either Moslem commentaries heavily influenced by watered-down Greek and Hellenic authorities—of whom the Moslems had been the first heirs—or translations of the classic physicians clouded by a long course of interpretation from Greek, sometimes to Syriac, thence to Arabic, sometimes to Hebrew and finally into Latin. Under these conditions a resurrected Galen might well have failed to recognize his own writings.

The first two figures of any merit to be found in Europe at the opening of the sixteenth century were the anatomists, Alessandro Benedetti (1460-1525), asso-

6. Galen, *On the use of the parts,* IV-VI, *passim,* in Kuhn, III, pp. 266-608; also *Oeuvres de Galien,* trans. Ch. Daremberg, I, Paris, 1854, pp. 278-523.
7. Galen, *On anatomical procedures,* VIII, trans. Charles Singer, London, 1956, pp. 200-25.
8. The remarkable description of the lesser circulation made in the thirteenth century by Ibn Nafis is not considered here, since it was not influential in the evolution of physiology in Europe. The isolated achievements of Leonardo have been ignored for the same reason.

ciated with the medical school of the University of Padua, and Alessandro Achillini (1463-1512) of Bologna. Both had performed human dissection, but both viewed the cardiovascular system largely through the eyes of Aristotle and to a lesser degree through those of Galen. The heart, wrote Benedetti, is the source of blood and the center of sensation.[9] Both men asserted that the heart possessed three ventricles, and Galen was reprimanded for his criticism of Aristotle on this point.[10] Benedetti plainly announced that there was no terminal anastomosis between vein and artery[11] and that the cardiac septum was solid.[12] Clearly arterial and venous blood were distinct and separate, while pulsation was the work of the vital spirits in the heart. It is interesting to note that both these men described correctly and appear to have known the operation of the cardiac valves[13] discovered by Erasistratus, yet the implication of such knowledge appears to have made no impression upon them.

The appearance in print of the Greek texts of Galen and, more important, accurate Latin translations of them, was slightly later than the similar appearance of the writings of Aristotle. By the end of the first quarter of the sixteenth century, however, Galen was beginning to compete for predominance, although his final victory over the Arabo-Aristotelian forces was gained only after fierce struggle. The importance of Galen's victory lay in the fact that, despite the temporary bondage he was about to acquire over anatomy and physiology, his views on the cardiovascular system were somewhat saner than those of Aristotle, and Galen's doctrines could, with less dislocation, eventually be altered in the direction of an understanding of the true motion of the blood.

The first notable follower of Galen in the sixteenth century was the Bolognese anatomist Berengario da Carpi (1470-1550). Berengario's *Commentary* on the medieval anatomist Mundinus, published in 1521, by its size, by the novelty of its illustrations and by its obvious dependence upon a certain degree of human dissection played no small part in the final victory of Galen over the earlier Arabic authorities. On the question of the number of ventricles of the heart, however, Berengario made a compromise, concluding that there were three, but that the third ventricle was to be found not as a single cavity but rather as many small cavities,[14] that is, the hypothetical pores in the septum of the heart which were said to permit the transit of blood from the right ventricle into the left. Hence physicians and anatomists now had a second reason for examining the septum with special care.

A notable investigator of this problem was Niccolò Massa (d. 1569), a Venetian surgeon and anatomist, who had to his credit at least four human dissections, and in 1536 Massa published a small anatomical treatise in which he declared his belief that there was no third ventricle in the midwall of the heart, since "that wall is dense and hard substance without any cavity."[15] In other words, Massa denied the porous nature of the cardiac septum. Since Massa gave allegiance in general to Galen, this meant, or at least implied, that closure of this route required the use solely of Galen's alternate route for the blood passing from the right ventricle into the left, that is, a transit from the pulmonary artery into the pulmonary vein. Massa did

9. *Historia corporis humani*, Venice, 1502, cap. xxi.
10. *Ibidem*, cap. xiii; Achillini, *Anatomiae annotationes*, Bologna, 1520, f.IXr.
11. Benedetti, *op. cit.*, cap. ix.
12. *Ibidem*, cap. xiii.
13. *Ibidem*, capp. xiv-xvi; Achillini, *op. cit.*, f.IX r-v.
14. *Commentaria super anatomia Mundini*, Bologna, 1521, F. 347r.
15. *Liber introductorius anatomiae*, Venice, 1536, f. 56v.

not express himself, however, on this matter.

Berengario and Massa may be termed the first of that new school which not only dissected the human body and sought to arrive at the truth by their own independent researches and observations but from time to time courageously opposed the well-nigh sacred authority of Galen. The most famous anatomist of this new school was, of course, Andreas Vesalius (1514-1564), who seems to have profited from the efforts of his Venetian predecessor Massa. As regards the cardiovascular system, the most notable statement to be found in Vesalius' *Fabrica* of 1543 is one that echoes Massa's words. Referring to the pits on the surface of the cardiac septum, sometimes considered the entrances to the mythical pores, he remarked: "None of these pits—at least in so far as can be ascertained by the senses—penetrates from the right ventricle into the left."[16] The greater prestige of Vesalius naturally gave more weight to this statement than had been given to that of Massa. Furthermore, Vesalius stated elsewhere in the *Fabrica* that he had sought to examine the human heart before death, that is, before the asserted shrinkage of the septum and disappearance of the pores, and tells of a victim of quartering alive that "At Padua . . . I undertook to have his still pulsating heart carried immediately to the nearest pharmacist's shop."[17]

Nevertheless, all such statements were still negative. The first positive statement, that is, the first European effort to provide a new route for the blood, was that of the Spanish theologian and physician, Michael Servetus (1511-1553). This first printed description of the pulmonary circulation is to be found in his theological treatise entitled *The Restitution of Christianity*, published in 1553. There exists, however, an earlier manuscript version of the work containing the description of the blood's passage through the lungs, and this can be dated approximately 1546.

It seems possible that Servetus came upon his discovery through a combination of some knowledge of anatomy, a thorough knowledge of Galen, and a flash of intuition, possibly triggered by Vesalius' earlier pronouncement. It may appear curious, perhaps, that this description of the pulmonary transit of the blood is to be found in a theological work, but the fact is that Servetus retained the Galenic idea of a spirituous blood carried through the entire body; however, where Galen spoke of the vital spirits or pneuma in the arterial blood, the pantheistically inclined Servetus was concerned with the distribution through the body of an inspired divine spirit. Hence Servetus' primary concern remained theological, and his description of the pulmonary circulation may be called a kind of casual employment of anatomy and physiology to assist in the establishment of a point of theology.

In the course of his description, after remarking that the right ventricle of the heart transmits its blood to the left ventricle, Servetus added: "not through the middle wall of the heart, as is commonly believed, but by a very ingenious arrangement . . . by a long course through the lungs." This, he wrote, represented "a truth which was unknown to Galen," and we may add that it also represents a difference of emphasis. The basic problem of both Galen and Servetus was that of moving the blood from the right ventricle of the heart to the left. Galen's solution, as we know, was to have a portion of it make a transit through the supposed pores in the heart's septum from right to left, while a smaller portion traveled from the right ventricle through the pulmonary

16. *Fabrica* (1543), VI, xi, p. 589.
17. *Ibidem*, VI, viii, p. 584.

artery and vein and so into the left ventricle. What Servetus did was to reverse this process, declaring that almost all such blood followed the route from the pulmonary artery to the pulmonary vein, and as a sop to Galenic tradition he agreed that there was the possibility that "something may possibly sweat through" the cardiac septum. Essentially, however, Servetus considered that the blood moved

> "by a long course through the lungs; it is elaborated by the lungs, becomes reddish and is poured from the pulmonary artery into the pulmonary vein. Then in the pulmonary vein it is mixed with inspired air and through expiration is cleansed of its sooty vapors. Thus finally the whole mixture, suitably prepared for the production of vital spirit is drawn onward from the left ventricle of the heart by diastole."

Only in this way, wrote Servetus, can the communication of the pulmonary artery with the pulmonary vein in the lungs be explained; otherwise the very size of the pulmonary artery is inexplicable. Furthermore, not merely air, but air mixed with blood is sent from the lungs to the heart through the pulmonary vein. Hence the mixture must occur in the lungs rather than in the heart. Finally, the middle wall of the heart, lacking vessels, is not suitable for that necessary communication and elaboration of the blood.[18]

Here, then, are the raw essentials of the pulmonary circulation. Servetus still recognized the blood as containing natural, vital and animal spirits, ingredients which remained in it until well into the seventeenth century. The heart was still the body's furnace, giving off excrement in the form of sooty vapors, while the cardiac valves, unless included in the phrase "ingenious arrangement," played no role of importance.

No sooner did the *Restitution of Christianity* appear in 1553 than it promptly disappeared, owing to the rigorous activity of religious authorities, and the author himself was condemned and permanently silenced in that same year. It does not seem that Servetus' book was influential in the production of later descriptions of the pulmonary circulation. The idea was in the air, and others were on the verge of a similar result—more, probably, than finally expressed themselves in the permanence of print.

The next noteworthy event in the history of this development was the appearance in 1555 of the second edition of Vesalius' *Fabrica*, in which the author announced in somewhat more emphatic terms than in the first edition that "whatever else I may think of the pits (i.e., the alleged pores in the cardiac septum), I have no knowledge that even the smallest amount of blood may be taken through the substance of the septum from the right ventricle into the left, especially since the vessels gape by such large orifices into the ventricle."[19] Moreover, continued Vesalius, with regard to the heart and the movement of the blood, "many things present themselves which call into doubt the ordinary conclusions of anatomists but which it would take too long to consider at present, and I have decided not to alter things piecemeal—although at the same time I am by no means fully satisfied."[20] How far Vesalius had progressed beyond the Galenic doctrine we have no way of knowing, since, as he wrote, he intended to wait until he could give a satisfactory description of the entire mechanism and physiology of the heart and lungs before introducing any radical changes in his account. Whatever he may have learned about the cardiovascular system died unborn with his death just as he was about

18. Michael Servetus, *A translation of his geographical, medical and astrological writings*, London, 1953, pp. 204-05.

19. *Fabrica* (1555), VI, xi, p. 734.
20. *Ibidem*, VI, xv, pp. 746-47.

to resume his old chair of anatomy at the University of Padua.

It should be no cause for astonishment that increasing human dissection and observation, a greater concern with vivisection and growing independence of past authority should lead others along the same path. In 1556 the Spanish anatomist Juan Valverde (fl. 1550), then living in Rome, published a treatise containing a brief description of the pulmonary circulation. Although his account resembles a brief preliminary report, he denied, on the basis of research, that there was any passage of blood directly from the right ventricle of the heart into the left. He emphasized the fact that the pulmonary vein is filled with blood, although according to Galenic doctrine it ought to contain also inspired air or vapors expired from the heart. Since valves prevented the flow of blood from the left ventricle into the pulmonary vein, such blood must come from the pulmonary artery.[21] The tenor of this brief account is more anatomic than that of Servetus, which is hardly strange, since Valverde was not only a practicing anatomist but was working in conjunction with the still more capable Realdo Colombo (1516?-1559), who had settled in Rome in 1548.

Although Colombo's much more extensive discussion of the pulmonary circulation appeared posthumously in 1559, it is most likely that he had reached his conclusions as early as and probably conjointly with Valverde. Colombo was a highly skilled anatomist, and his description, arrived at possibly ten years after that of Servetus, contains, as we might expect, much more detail and several contributions. According to Colombo, the blood was moved from the right ventricle through the lungs and into the left ventricle much as had been described by Servetus. The significant role of the valves, however, was now pointed out—preventing regress of the blood and compelling its flow always in the same direction. The septum of the heart was completely impermeable, and the mixture of air and blood occurred in the lungs, so that the labor left to the heart was slight, merely a "finishing touch." The fact that any of the elaboration of the blood was left to the heart may have been a sop to Galen, just as Servetus had been willing to grant that some slight amount of blood might seep through the cardiac septum. Possibly because the heart played little part in the elaboration of the blood, Colombo denied the pulmonary vein any part either for cooling the heart or carrying off sooty vapors.[22]

Colombo's *De Re Anatomica* was widely read and frequently quoted, and it was due chiefly to the currency gained by this particular book that the medical world came to be divided into two definite camps: those who remained faithful to the Galenic doctrine and those who braved authority to support the new doctrines—if not the pulmonary transit of the blood as outlined by Colombo, at least some route alternate to that proposed by Galen.

While there is not time at present to consider individually all the members of this new school which seems to have stemmed from Colombo, brief consideration must be given to one of them, Andrea Cesalpino (1524-1603), since occasionally he has been declared to have been Harvey's predecessor in the discovery of the general circulation of the blood. His description of the cardiovascular system, however, suggests some unfamiliarity with its anatomy, while his allegiance to the new doctrine of the pulmonary circulation required the impossible feat of reconciling

21. *Historia de la composicion del cuerpo humano*, Rome, 1556, f.97. The passage has been translated into English in the *J. Hist. Med. and Allied Sci.*, 1953, 8:456-57.

22. *De re anatomica*, Venice, 1559, Bk. VII.

Aristotle, Galen and the new anatomy based upon independent observations. Treated as a whole, his text certainly does not support the credit which has occasionally been extended to him.[23] Of the Italians who shared in the development of those ideas leading finally to Harvey's achievement, Colombo's contribution was the most important and influential.

In his notes for the Lumleian lectures of 1616 Harvey frequently quotes Massa, Vesalius, Colombo and some of their successors. As he was aware of the work performed by these men in the development of knowledge of the pulmonary circulation, so too he was aware of the discovery of valves in the veins. It has already been indicated that knowledge of the cardiac valves had been available since the time of Erasistratus, and, while Vesalius devoted an entire chapter to them in the *Fabrica,* Realdo Colombo appears to have been the first to employ knowledge of their operation in any particular degree as part of the proof of the pulmonary circulation.

The venous valves, first discovered around the middle of the sixteenth century, appear to have been looked upon as a curiosity lacking any fundamental importance,[24] and as a result interest in them declined until they underwent a kind of rediscovery in 1574 by the Paduan professor Fabricius of Acquapendente (1537-1619), and from then on Fabricius and his German student Salamon Alberti (1540-1600) gave more and more attention to the matter. In 1585 Alberti published an account that had the merit of containing the first illustrations of the valves;[25] and in 1603 Fabricius published his superior and almost classic study with its fine copper engravings.[26] Nevertheless, while Fabricius described the structure, distribution and position of the valves, as well as the fact that they opposed the reflux of the blood, he nevertheless thought that the lumen of the vessels was only partially closed by the valves and so failed to deduce both their true function and their larger significance in the circulation of the blood.

Thus, by the end of the sixteenth century the mechanism of many factors related to the circulation of the blood had been discovered, but as yet no one had realized their implications as a whole. The true meaning of the valves and the ever-constant motion of the blood in one direction were as yet not comprehended. Moreover, Galen's doctrine of a limited production and consumption of blood still held the field and so limited understanding of the true volume of blood and the rapidity of its motion, a motion, incidentally, as yet considered the result of attraction rather then of propulsion. Such problems were to be resolved in the seventeenth century, but before we consider that century there are a few other aspects of the physiology of the sixteenth century which ought to be mentioned.

While the sixteenth century was much concerned with the question of cardiovascular function, this was by no means its only concern with physiology. It has already been mentioned that in 1542 Jean Fernel employed the term *physiologia* as a title in his study of the normal functions of the body. About fifteen years earlier Guinter of Andernach (c. 1500-1574), professor of anatomy in the Paris medical faculty, had undertaken the investigation of such normal functions in animals by means of vivisection,[27] and although he

23. For example, he appears to have recognized three ventricles in the heart, *Quaestiones peripateticae,* Venice, 1593, f.118r, to have believed the cardiac septum permeable, *ibidem,* f.126r, and to have regarded the passage of blood through the lungs as solely for its refrigeration, *ibidem,* f.125v.

24. The venous valves seem to have been discovered by Charles Estienne at some time prior to 1545. Their existence was next recorded in 1546 orally by Giambattista Canano, mentioned by Amatus Lusitanus in 1551, again by Vesalius and Jacobus Sylvius in 1555, and by Colombo in 1559, after which time they were ignored for approximately fifteen years.

25. "De valvulis membraneis quorundam vararum," in his *Tres orationes,* Nuremberg, 1585.

26. *De venarum ostiolis,* Padua, 1603.

27. *De medicina veteri et nova,* Basel, 1571, I, p. 261.

published no results it is very likely that he introduced his favorite student Andreas Vesalius to this method of physiologic investigation. Vesalius continued the procedure while in Padua and did publish some of his results.

In addition to what he contributed to the advancement of knowledge of the heart and motion of the blood, Vesalius devoted the final chapter of the *Fabrica* to a description of his procedure in vivisection and the results he achieved.[28] While it is not within the scope of this paper to describe all his investigations, it may be said briefly that Vesalius revived some of Galen's experiments, such as the ligation of the recurrent laryngeal nerve, assuming, of course, that he had blocked off the animal's spirits which flowed through the hollow nerves; and by stripping away the nerve sheath Vesalius indicated that the impulse, whatever it might be considered to be, traveled through the nerve itself. In addition, he demonstrated that dogs could survive splenectomy and, also using the dog, his favorite animal for research, he cut away a rib and all underlying parts as far as the undamaged and transparent pleura and so was able to see the lung in motion. His favorite demonstration, and certainly the most spectacular, was that in which he thrust a reed into the trachea of an animal in which the lungs were already collapsed and the heart had almost ceased beating. Then, by artificial inflation of the lungs, he was able to restore the heart to its normal activity.

No doubt similar physiologic studies were undertaken by others who did not write up their experiments except with regard to that most popular aspect of the subject, that is, cardiovascular function. The exception was Realdo Colombo, originally an assistant to Vesalius and no doubt influenced by him. Colombo's studies, which covered pretty well the same ground as those of Vesalius, were described separately from his anatomic studies and so once again suggested a growing recognition of the distinction between anatomy and physiology.

With the opening of the seventeenth century physiology was on firmer ground. It was beginning to gain recognition as a separate subject for investigation and was now to be greatly aided by the new developments in mathematics, physics and chemistry. Physiology arose as a separate discipline in the formative period of the new academies of science and learned societies and had great appeal for the members of those organizations, who in turn provided support and publicity.

In addition to such substantial benefits, however, physiology was to enjoy the new spirit of scientific enquiry. By the end of the previous century the more courageous investigators had greatly loosened the bonds of Galenic authority and bequeathed to the men of the newer age freedom to employ the method of Galileo (1564-1642) and like René Descartes (1596-1650) to cast doubt on all previous knowledge as the first step toward wisdom. Indeed, both Galileo and Descartes had direct ties with physiology. Galileo was closely associated with the work of his fellow-professor Sanctorius (1561-1636), whose studies of insensible perspiration mark him not only as a pioneer in the investigation of metabolism but the first physiologist of the new century to employ significantly both the new scientific procedure and new scientific instruments constructed specifically for his studies.[29] As for Descartes, his posthumous *De Homine* has frequently been termed the first

28. *Fabrica* (1543), VII, xix, pp. 658-659 [663], "De vivorum sectione nonnula."

29. *De statica medicina, aphorismorum sectionibus septem comprehens*, Venice, 1614. A selection from this work is to be found in John F. Fulton, *Selected readings in the history of physiology*, Springfield, Illinois, 1930, pp. 140-45.

monograph of modern times on physiology.[30]

Of course, the great achievement of the age was that of William Harvey (1578-1657), an achievement without previous parallel. Having established a hypothesis of the circulation of the blood in his Lumleian lectures of 1616,[31] he spent the next twelve years amassing and testing evidence in support of this single thesis. So firmly was the proof woven together that it could be doubted only by those still irrationally directed by emotions and past authority, and it is a problem whether to give greater applause to Harvey's method or to the substance of his presentation.[32]

As the old philosophies died, as the natural, vital and animal spirits were perishing, new philosophies were in the course of development to fill the void, sufficient indication that the science of physiology had come into being; and although the several new philosophies were often in conflict, nevertheless specific and undeniable developments in physiology continued, especially in those areas assumed to be most closely associated with cardiovascular function.

Harvey, without the technical means to substantiate, had been able only to postulate the existence of hairlike or capillary vessels connecting arteries and veins. This final link in the chain of proof of the circulation, the closing of the circle, was provided in 1661 by Marcello Malpighi (1628-1694) of Bologna, who described the capillaries in the frog's lung,[33] and in 1688 the Dutchman Anthony van Leeuwenhoeck (1632-1723) provided further and elaborate confirmation.[34] In 1658 the red corpuscles in the blood had been observed by another Dutchman, Jan Swammerdam (1637-1685).[35] At the time, however, no importance was placed upon this observation; even Malpighi in 1665 considered them nothing but fat globules,[36] until finally interest was aroused in this matter by a description contributed to the Royal Society by Leeuwenhoeck.[37] These advances, be it noted, had had to await the wedding of physiology and optics, which then gave birth to the microscope. Finally, skipping to the eighteenth century, mention must be made of the contribution to knowledge of the blood pressure made by Stephen Hales[38] (1677-1761), which has been called "the greatest single contribution to knowledge of the vascular system after Harvey."[39]

Turning to another aspect of the subject, it should be observed that the lacteals, first observed in 1622 by Gaspar Aselli (1581-1626), were described in his posthumous book of 1627.[40] In 1651 Jean Pecquet (1622-1674) discovered the thoracic duct and traced the relation between it and the lacteals,[41] and in his *Vasa Lymphatica* of 1653 Thomas Bartholin

30. *De homine figuris et latinitate donatus a Florentio Schuyl*, Leyden, 1662; the original French text did not appear until 1664. As a statement of fact rather than a work of noteworthy significance, however, the first textbook of physiology was that of Walter Charleton, *Natural history of nutrition, life and voluntary motion*, London, 1659.

31. "From the structure of the heart it is manifest that the blood is carried constantly through the lungs into the aorta 'as by two clacks of a water bellows to rayse water.' By the use of ligation it is clear that there is a transit of blood from arteries to veins, wherefore the beat of the heart produces a perpetual circular motion of the blood," *Prelectiones anatomiae universalis*, London, 1886, f.80v. ..

32. The contributions Harvey made in 1628 in *De motu cordis et sanguinis* have been admirably summed up by K. F. Russell in "Homage to Harvey," *The Medical Journal of Australia*, 8 June 1957, p. 777:1. The heart behaves like a muscle when it contracts and in action alternately contracts and relaxes. 2. In systole the apex of the heart strikes the chest wall, and the systole corresponds with and is the cause of the peripheral arterial pulse. This can be shown by the spurting of the blood when an artery is cut. 3. Contraction of the auricles drives blood into the ventricles, and auricular contraction is followed by ventricular contraction. 4. Once blood has entered the aorta or pulmonary artery, it cannot go back, being stopped by the valves. 5. The amount of blood entering the arteries from the heart is, over a given period, very great. . . . 6. The blood so moved into the arteries comes from the veins. Harvey postulated that there were very small communications at the periphery between the arteries and the veins. . . . 7. In the peripheral veins, the valves will allow the blood to travel only in a central direction."

33. *De pulmonibus. Observations anatomicae*, Bologna, 1661. The pertinent passage is given in Fulton, *op. cit.*, pp. 62-7.

34. *Ibidem*, pp. 68-75.

35. The observation was published in his posthumous *Biblia naturae*, Leyden, 1737-38.

36. *De omento, pinguedine et adeposis ductibus*, in his *Epistolae anatomicae . . . ad Alphonsum Borellium*, Bologna, 1665.

37. *Phil. Trans. Royal Society*, 1674, 9:121-8.

38. *Statical essays: containing haemastaticks; or, an account of some hydraulick and hydrostatical experiments made on the blood and blood-vessels of animals*, London, 1733; pertinent selections in Fulton, *op. cit.*, pp. 75-9.

39. John F. Fulton, *Physiology*, New York, 1931, pp. 35.

40. *De lactibus sive lacteis venis*, Milan, 1627.

41. *Experimenta nova anatomica*, Paris, 1651.

(1616-1680) clearly demonstrated the relation of the lymphatic vascular system to the intestinal lymphatics.[42]

In one passage in the Lumleian lectures of 1616 Harvey mentions instances of suffocation resulting from the burning of charcoal in closed rooms and refers to certain kinds of air as unsuitable for respiration.[43] It may or may not have been a brief glimmer of comprehension that the air contained a specific and necessary ingredient for life. The subject was never referred to again, and it was only after Harvey's time that the science of physics produced instruments for such study. Hence in 1660 and 1682 Robert Boyle (1627-1691), employing the new air-pump to create a partial vacuum, was able to prove that both the light of a candle and the life of a mouse were simultaneously extinguished by lack of air,[44] and in 1667 Robert Hooke (1635-1703) further demonstrated the importance of air for the existence of life. Elaborating on Vesalius' experiment, he perforated a dog's lung, thereby introducing air into it, and proved that the air rather than the movement of the lung was the vital factor.[45] Two years later Richard Lower (1631-1691) succeeded in demonstrating a complementary truth to the effect that blood which had already passed through the lung was brighter in color, a fact which he ascribed to the absorption of air by the blood.[46]

These few developments demonstrate what could be accomplished in a brief period once a scientific method had been established and physiologists could call upon the other sciences for assistance. While it is true that any science is always in a state of evolution, there is always some period in the past to which we can refer as the beginning of a kind of continuing and virtually irresistible unfolding of the subject. In the present instance, that was the period which witnessed the establishment of physiology as a separate discipline just as the methods of science had gained recognition and could be used to test the accumulated information of the past and so separate the true from the false. Then, divorced from the restrictive authority of the past and wedded to those other suddenly vitalized sciences under the benevolent auspices of the new learned societies, the almost immediate accomplishments were sufficient evidence that physiology had reached maturity.

As the seventeenth century marked the fulfillment of evolution, so the eighteenth century may be termed the period of consolidation, as is evidenced by the appearance of textbooks of physiology such as the Medical *Institutes* of Hermann Boerhaave,[47] which was published in 1708 and retained its supremacy until Albrecht von Haller's monumental *Elements of Physiology* began to appear in 1757.[48]

The course of evolution had been a long one, of more than two thousand years, remarkable for its short bursts of rapid progress under the direction of the Alexandrians and Galen, but followed by a period of sterility which lasted for nearly fifteen hundred years before advances once more began to be made. Today it may seem incredible that it took virtually the entire sixteenth century to break the shackles of authoritarianism and with painful slowness to begin the development of that scientific approach to problems

42. *Vasa lymphatica nuper Hafniae in animantibus inventa, et hepatis exeguiae, Copenhagen,* 1653.

43. *Prelectiones,* op. cit., f.85v.

44. *New experiments physico-mechanicall, touching the spring and weight of air,* Oxford, 1660, *A continuation of new experiments . . . Second part,* London, 1682, cf. Fulton, *Readings,* pp. 107-09.

45. "An account of an experiment made by M. Hook, of preserving animals alive by blowing through their lungs with bellows," *Phil. Trans. Royal Society,* 2:539-540, 1667; cef. Fulton, *Readings,* pp. 109-11.

46. *Tractatus de corde. Item de motu & colore sanguinis,* London, 1669; cf. Fulton, *op. cit.,* pp. 116-18.

47. *Institutiones medicae, in usus annuae,* Leyden, 1708, which went through more than twenty editions.

48. *Elementa physiologiae corporis humani,* Lausanne and Berne, 1757-66, 8 vols.

which made possible the advances of the seventeenth century and after. Yet each man's contribution, large or small, was a vital link in the chain of development. Aristotle, Herophilus, Erasistratus and Galen, judged by what they did rather than by the self-enslavement to them of later times, and that small succession of sixteenth century investigators were the vital and necessary understructure supporting the efforts and great accomplishments of more modern times.

—*C. D. O'Malley, Ph.D.*
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In each new art practised as an enduring human activity, there must be a permanent element of illusion. Florence Nightingale knew this when she created her cult of sick nursing out of the homely business of housecraft. In her day, cleanliness and good housekeeping were common virtues, and many a lady of the manor practised unobtrusively, on a small scale, the sort of thing which made the Lady-in-Chief so remarkable at Scutari. The basis of it was the natural female instinct, and those village patronesses understood how to arrange sick beds, prepare invalid foods, and make bandages from torn-up sheets. Such gifts were not the exclusive discovery of Florence Nightingale. Her unique achievement was to create out of this feminine raw material a science and a status . . .

The notion of something distinct in the art of nursing, as contrasted with mere menial service, that there was in fact an influence in these routine administrations wholly beyond the effect of drugs had not dawned upon medical men. Florence Nightingale's quick success in the Crimea created this refined science, but she had not yet succeeded in putting across her idea as a permanent necessity of peace. After a war, the British public loves to relax, and those generous people who gave their money for the Nightingale memorial and said her work must never die, then prepared to treat it as nothing but a quaint heroism of wartime, desirable indeed in Scutari, but superfluous in Victorian home life. To counter this indifference Florence Nightingale had to professionalize her calling, making her standards stricter, her routine more inexorable . . .

Her greatest mission, then, was not to found the art of nursing. No one woman, not even she, could have invented what was very traditional. Her main business was with the woman more than with the science. To form an army of women not only faithful, but technically trained in a method that would never fail, and inspired with selflessness.

—*Williams*

New Books

BOOKS RECEIVED

The following books have been received by the Editor; they will be reviewed critically as space and facilities permit. Omission of more extended review, however, is not to be taken as criticism of the merit of the book.

Operative Surgery. Edited by Charles Rob and Rodney Smith. London: Butterworth & Co., Ltd.; Philadelphia, F. A. Davis Co., 1956. Vols. 1 and 2 of 8 (plus index). Profusely illustrated.

Proceedings of the Third National Cancer Conference, Detroit, Michigan, June 4-6, 1956. Sponsored by the American Cancer Society, Inc., and National Cancer Institute, U. S. Public Health Service. Philadelphia: The J. B. Lippincott Company, 1957. Pp. 961.

Le Diagnostic du Cancer d'Estomac a la Periode Utile (Diagnosis of Carcinoma of the Stomach at the Time Most Favorable for Treatment). By Rene A. Gutmann. Paris: G. Doin et Cie, 1956. Pp. 257.

Pathology and Surgery of the Veins of the Lower Limbs. By Harold Dodd and Frank Cockett. Baltimore: The Williams & Wilkins Company, 1957. Pp. 462, illustrated.

Spinal Cord Compression. By I. M. Tarlov. Springfield, Ill.: Charles C Thomas, Publisher, 1957. Pp. 147, with 41 illustrations.

The Reticular Formation of the Brain Stem. By Alf Brodal. Springfield, Ill.: Charles C Thomas, Publisher, 1957. Pp. 87, with 18 illustrations.

Functional Bracing of the Upper Extremities. By Miles H. Anderson. Springfield, Ill.: Charles C Thomas, Publisher, 1958. Pp. 463. Illustrated.

Der Lungenboeck im Röntgenbild (Boeck's Disease: Roentgenographic Aspect). By Karl Wurm, H. Reindell and L. Heilmeyer. Stuttgart: Georg Thieme Verlag, 1958. Pp. 220, with 180 illustrations. *Reviewed in this issue.*

Le Rein Descendu: Le Problème Clinique et Thérapeutique (The Ptosed Kidney: Clinical Problem and Treatment). By Luis A. Surraco. Paris: Librairie Maloine S.A., 1956. Pp. 240, with 60 illustrations. *Reviewed in this issue.*

The Clinical Management of Varicose Veins. By David Woolfolk Barrow. New York: Paul B. Hoeber, 1957. Pp. 167, with 70 illustrations.

The Story Behind the Word: Some Interesting Origins of Medical Terms. By Harry Wain. Springfield, Ill.: Charles C Thomas, Publisher, 1958. Pp. 342.

Homosexuality, Transvestism and Change of Sex. By Eugene de Savitsch. London: William Heinemann Medical Books Ltd., 1958. Pp. 120.

Pathophysiologische Grundlagen der Chirurgie (The Pathophysiologic Principles of Surgery). By Theodore Otto Lindenschmidt. Stuttgart: Georg Thieme Verlag, 1958. Pp. 410, with 40 illustrations. *Reviewed in this issue.*

Surgical Technique and Principles of Operative Surgery. By A. V. Partipilo. Philadelphia: Lea & Febiger, 1957. Pp. 551. Illustrated. *Reviewed in this issue.*

Concept et Synthese des Chocs (Concept and Synthesis of Shock). By Pierre F. Petit. Paris: Société d'Édition d'Enseignement Supérieur, 1958. Pp. 48, with 1 illustration, and 2 tables.

Dr. Petit presents a clear, concise exposé of shock, in which he emphasizes the importance of the defensive action of the contractile vasomotor against diverse aggression, such as fainting at sight of a hypodermic needle, crushing of a limb, myocardial infarct, noncompensating hemorrhage, operative shock, severe burns, occlusion of the small intestine with uncontrollable vomiting, or sudden hyperthermy. The preface by Prof. Paul Funck-Brentano emphasizes the brief and philosophic manner in which the author presents his original ideas on this complex subject.

Although many theories have been advanced as to the causation of shock (toxic, circulatory, nervous, etc.), the accepted form of treatment is systematic transfusion of blood or plasma and the use of vasopressors. It was the author who conceived the idea of the rôle of the contractile system (vasomotor) in the defense mechanisms against shock and aggression. In organic reaction to aggression the contractile system is the first line of defense, the endocrine the strategic director and the nervous system the sentinel and liaison agent (See diagram on Page 15 of article). This contractile action manifests itself primarily in areas in which capillaries are most numerous, fragile and sensitive to vasomotor action, i.e, at the level of the organs of exchange (kidneys, digestive tract, lungs), or in areas where capillaries have been made more fragile by a previous lesion.

It has been proved experimentally that irritation of the splanchnic nerve can bring on intestinal lesions, varying from simple infarct to true ulceration, due to capillary hemorrhage resulting from vasodilation and/or ischemia accompanying vasoconstriction.

From the pathologic point of view, any sensation and every aggression provoke and/or elicit a contractile action, which may explain certain hitherto unexplained phenomena of shock. It has been observed that grave cranial injuries may bring on pulmonary edema; extensive burns; renal or gastric hemorrhage; operative shock; or reactivation of gastric ulcers. Repeated small aggressions may bring about a state of "continual gymnastics" of abnormal contractile action causing certain illnesses, such as hypertension. Allergic phenomena have the same nature, requiring only sensitization to certain substances to set in motion abnormal contractile action.

Contractile action is normal and always present. Muscular tonus, vascular tonus, glycemia and respiratory rhythm vary according to physiologic requirements.

Therapeutic ACTH or cortisone, which act on the contractile system, are able to reactivate preexisting silent lesions, such as digestive ulcers. Coagulation of frontal lobes stimulates the hypothalamus and endocrine system, causing contractile action and arrests certain hemorrhages of capillary origin in the digestive tract. The author states that direct transfusion, often considered a hemostatic agent, does not act on the coagulating mechanism except in the presence of hemophilia, in which the blood is deficient in coagulating substances. Transfusion acts as an aggressor and brings about contractile action in injured capillaries, reinforcing an impaired hemostatic mechanism.

There are two schematic drawings in color. One depicts the interrelation of the vascular, nervous and endocrine systems in bringing about contractile action of the vasomotor capillaries in aggression; the others the humoral and contractile changes associated with operative shock, hemorrhage, destruction of tissues, hyperthermy, fear or pain.

The author points out his concept of the manner in which the body reacts to aggression, based on well-known physiologic and pathologic facts, without philosophic digression.

CHARLES PIERRE MATHÉ, M.D.

Pathophysiologische Grundlagen der Chirurgie (The Pathophysiologic Principles of Surgery). By Theodore Otto Lindenschmidt. Stuttgart: Georg Thieme Verlag, 1958. Pp. 410, with 40 illustrations.

Dr. Lindenschmidt has successfully accomplished the formidable task of setting forth the synthesis of pathophysiologic data and clinical surgical principles. This is not a general textbook on pathologic physiology. More specifically, it transmits to the surgeon engaged in practice or in research the current knowledge of the subject so far as it applies to all phases of surgical diagnosis and therapy.

This is the first German book in many years that is concerned with this particular field of medicine. Prof. L. Zukschwerdt (Chirurgische Universitaetsklinik Hamburg - Eppendorf) comments in the perface that the advance in surgery during the last few decades has been due, to a considerable extent, to the application of physiologic learning. Knowledge of physiology has become increasingly important and frequently indispensable for the proper choice of preoperative and postoperative therapy for nearly all surgical conditions. These facts determined the pattern of construction employed in the book. Its first five chapters are devoted to protein, carbohydrate and fat metabolism and the role of water, minerals and vitamins in surgery. A review of the normal physiologic picture precedes the discussion of each subject.

The next fourteen chapters deal with functional disorders and surgical conditions of individual organs and of various organic systems from a pathophysiologic point of view. Pathologic physiology of the gastrointestinal and urinary tracts and the respiratory, cardiovascular, locomotor, nervous and endocrine systems is discussed in relation to diagnosis and therapeutic measures. The last two chapters deal with pathophysiologic problems of grafting and surgical treatment of the aged.

General literature on the subject is well represented in the text. Established facts are described with the utmost clarity, and unsolved yet important issues are briefly noted. An array of references, alphabetically and neatly arranged, concludes each chapter. Tables, graphs .and figures are instructive, and format and printing are excellent. Unfortunately, the English titles in the bibliography contain many errors in spelling, omissions or contractions of words, etc., sometimes to the point of loss of meaning. (At least in the experience of one reviewer, careless proofreading has been an international malady far too long. Repeated mention of such regrettable negligence appears to be the best therapy for its gradual eradication.)

Aside from this minor but nevertheless objectionable point, the book is splendidly organized and clearly and concisely written. Because of limitation of space it would be futile to choose even a few highlights from the multitudinous topics so beautifully presented. It is sufficient to state that this text provides a wealth of information valuable to everyone. It should serve as a refresher and guide to the general as well as the specialized surgeon, and it should be a "must" for most surgical residents and assistants.

Although the subject has been more or less covered by books in the English language, this work is highly recommended for additional reading. It will be especially welcomed by surgeons in German-speaking countries, and it is well deserving of an English translation to gain wider attention. The author is to be congratulated on a difficult job remarkably well done.

ERNEST G. ABRAHAM, M.D.

Hormonal Regulation of Energy Metabolism. Compiled and edited by Laurance W. Kinsell. Springfield, Ill.: Charles C Thomas, Publisher, 1957. Pp. 242.

The author has done a magnificent job of presenting and compiling the presentations and discussions held during the 1956 Metabolic Conference. The subjects covered deal with (1) carbohydrate metabolism; (2) hormonal regulation of enzymatic activity; (3) the anterior pituitary in relation to energy metabolism; (4) the mechanism of the influence of pituitary growth hormone on metabolism; (5) the thyroid in relation to energy metabolism; (6) insulin; (7) diabetes and the insulin problem, and (8) the adrenal cortex and energy metabolism. These topics are presented in a manner that is easy to read and

understand, and the discussions following each subject are particularly informative, stimulating and authoritative.

This book is recommended to general practitioners, internists, endocrinologists, clinical investigators and fundamental scientists.

A. MAUER, M.D.

Der Lungenboek im Röntgenbild (Boeck's Disease: Roentgenographic Aspect). By Karl Wurm, H. Reindell and L. Heilmeyer. Stuttgart: Georg Thieme Verlag. 1958. Pp. 220, with 180 illustrations.

The authors present an unusually complete and thorough study concerning the diagnosis of pulmonary sarcoidosis (Boeck's disease), based on extraordinarily extensive material on about 400 patients of their own.

The "morbus Boeck" is a granulomatous inflammatory disease of still unknown causation, which occurs sometimes as an acute but most often as a chronic condition with a great variety of clinical manifestations. It may affect the entire mesenchymal system but involves always the lymph nodes and in 60 to 70 per cent of cases the lungs. Consequently, radiographic examination of the chest is of the utmost significance in the diagnosis of the disease. The fact that it often remains unrecognized is mainly due to the frequent discrepancy between massive roentgenographic alterations of the lungs and the mediastinum and the insignificance or absence of clinical signs and symptoms.

Owing to their close association with a fairly large tuberculosis sanatorium and a clinic for chronic eye disease, the authors were in a position to collect and analyze their impressive number of clinical cases.

It is interesting to learn that 6 per cent of more than 1,200 patients affected by chronic inflammatory eye conditions presented bilateral enlargement of the hilar lymph nodes of the mediastinum, a significant radiographic feature of Boeck's disease.

More than 80 per cent of the 200 pages of the book represents an atlas of pulmonary sarcoidosis, consisting of 143 radiographs from 63 selected cases of the author's material and about 30 other conditions illustrating the differential diagnostic features. Each roentgen picture is thoroughly analyzed and described, and the clinical data, the laboratory values and the therapeutic procedures performed on each patient are adequately discussed.

It becomes evident on reviewing the illustrations that the authors' attempt at classifying pulmonary sarcoidosis in three stages has been successful and helps to eliminate many confusing differential diagnostic problems which the radiologist encounters frequently.

The illustrations and the entire format of the book are of the highest quality. The authors, intending to present their own material exclusively, have entirely omitted a bibliography and explain that the opinion of others on the subject presented, together with a review of the literature, will be published at a later date in the *Handbook of Tuberculosis*. From the standpoint of the student of Boeck's sarcoidosis this omission is regrettable. In every other respect the book presents to the radiologist, as well as to the clinician, a most comprehensive and illuminating study of the subject.

FRITZ ROTHBART, M.D.

Current Medicine, 1957. By Muhammad Siddique. Qureshi Karachi, Pakistan: Q Publications, 1957. Pp. 212.

The author presents in this volume a series of articles on topics ranging from the prevention of coronary disease to the oral antidiabetic drugs and covering a variety of themes related to obstetrics and therapeutic aids. The articles in the main are unrelated, and an attempt is made to bring out topics of particular interest to physicians in Pakistan, many of whom have little access to current literature.

From this point of view the author has performed a major service for his colleagues in Pakistan in bringing material up to date and presenting current concepts in this rather small volume. It represents an important contribution to the literature of Pakistan.

A. MAUER, M.D.

Le Rein Descendu: Le Problème Clinique et Thérapeutique (The Ptosed Kidney: Clinical Problem and Treatment). By Luis A. Surraco. Paris: Librairie Maloine S.A., 1956. Pp. 240, with 60 illustrations.

There is great need for this timely book on the movable kidney. Nothing is more common than ptosis of the kidney, yet there is great controversy in the understanding of its clinical entity and management. Prof. Surraco's book reflects the efforts of progressive urologists to clarify surgical treatment.

The basic theme is the problem of pain and functional syndrome caused by the ptosed kidney and its treatment by nephropexy. The clinical entity is composed of three syndromes: (1) *urinary* (continuous lumbar pain, intermittent attacks of Dietl's crisis, diuresis, hematuria, orthostatic albuminuria, etc.); (2) *gastrointestinal* (gastroduodenal disturbances simulating hypotonic dyspepsia, anemia, deformation of veretebral column, etc.), and (3) *psychic* (neurasthenia).

The physical signs are elicited by palpation, retrograde pyelographic study with the patient in the horizontal and vertical positions, etc. The author points out that the symptoms of right-sided abdominal disease in women, are due in 80 per cent of cases to gastrointestinal or gynecologic lesions; in the other 20 per cent they are due to renal ptosis, in which dyspepsia plays an important role.

The author's long clinical experience has led him to favor surgical intervention when indicated. He emphasizes nephropexy as the corrective procedure of choice for the pathologic condition caused by ptosis of the kidney. It is essential that clinical symptoms be due to renal ptosis and torsion. Success of the operation depends on proper technic. A complete table outlines the etiology, symptoms, pathologic pictures, surgical treatment, etc.

An excellent chapter is devoted to the sensory and muscular syndrome of renal colic. It is based on knowledge of the topographic anatomy of the viscera, the physiology of innervation and physiologic and pathologic reaction to pain and muscle contraction.

The author points out that the lumbar route is the most direct surgical approach to the ptosed kidney. It assures good exposure, minimum shock and prompt healing and conserves tonicity and sensitivity of the lumbar and abdominal musculature. He describes the capsular method he uses in nephropexy. The superior two-thirds of the capsule is incised longitudinally, and the resulting flaps are attached to Henle's ligament below the twelfth rib by two rows of sutures, thus suspending the kidney. An incision is made in the posterior peritoneum, and the strangulated duodenum is freed from constricting bands. This is a good procedure, but it does not provide for fixation of the kidney at a higher level when advisable. Furthermore, it makes surgical mobilization of the kidney and subcapsular nephrectomy much more difficult when secondary operation is required.

Seventy-three pages are devoted to ectasia of the renal pelvis. The author calls attention to the complexity and lack of understanding of hydronephrosis. He elucidates the regional anatomic, etiologic, symptomatic, and therapeutic aspects. There are clear illustrations, ureteropyelograms and microphotographs of various anatomic and pathologic conditions. Indications for operation on small, medium, large and giant hydronephroses are described. The author's description of his technic for the correction of hydronephrosis is accompanied by excellent illustrations. He calls attention to the fact that similar ectasia may exist in the pylorus, the esophagus and the bladder.

Small hydronephrosis due to ptosis and torsion is corrected by nephropexy. The technic consists of a lumbar approach, the splitting of muscles, the freeing of the ureter from obstructing bands, folds or anomalous vessels and the fixation of the kidney in the proper position.

The last chapter pertains to the problem of perinephritis and periduodenitis associated with ptosed kidney. The anatomic relation of the renal fossa, containing the kidney and adrenal gland, to the duodenum is considered. Posterior perinephritis and anterior periduodenitis accompanying descent of the kidney may cause traction and dilation of the duodenum. Descent of the liver is an added factor and causes slipping of the infrahepatic portion of the peritoneum, favoring descent of the

duodenum, and interferes with its dynamic physiologic function. In some instances this may explain the gastrointestinal symptoms (frequently accompanying renal ptosis) which are predominantly gastroduodenal, hepatic or colonic. The author states that in differential diagnosis of duodenal ectasia, when the cause is obscure, one should suspect periduodenitis of renal origin. Diagnosis is made by carrying out, simultaneously, pyelographic and gastroduodenographic studies. Films taken with the patient in the standing position, after inspiration and expiration, reveal traction on the duodeum by the ptosed kidney. Dilation of this viscus is due to the adhesions resulting from perinephritis and periduodenitis. A number of postoperative films demonstrate relief of duodenal stasis after nephropexy.

The text is well written, and the schematic drawings, films and other illustrations are excellent. Urologists, surgeons and internists may well benefit from reading this important volume. Indications for nephropexy are clearly defined, and, as the author states, when properly performed will give excellent lasting results. The rationale of nephropexy is enhanced by the author's original work on the role of perinephritis and periduodenitis on duodenal stasis. Professor Surraco has greatly aided in solving the difficult problem of surgical treatment of ptosis of the kidney.

CHARLES PIERRE MATHÉ, M.D.

Surgical Technique and Principles of Operative Surgery. By A. V. Partipilo. Philadelphia: Lea and Febiger, 1957. Pp. 951. Illustrated.

The sixth edition of Dr. Partipilo's well-known book has been brought up to date in every detail, and thirty-eight new chapters have been added. The chapters on radioactive isotopes, covering the physical basis and therapeutic indications for isotopes, are particularly well written. Many chapters have been rewritten and are well illustrated. An important feature of the book is the bibliography following each chapter, preceded by a list of questions pertinent to the preceding chapter, which bring out and emphasize the subject covered.

Dr. Partipilo and his eighteen contributors are to be congratulated on the excellent, clear and concise manner in which this book is written. It is a valuable contribution to the surgical literature and is recommended to undergraduate student, general practitioner and general surgeon alike.

A. MAUER, M.D.

The good American is courageous, independent, self-sufficient, distrustful of tradition, a pioneer by instinct, able to make quick decisions and to act upon them. He has also a genuine sympathy for his fellow men, particularly if they are ill or down on their luck. When a man of this stamp undertakes surgery under ideal conditions, in theatres beautifully built and lit, helped by expert anaesthetists, assisted by a large team of skilled graduates, and served by a theatre sister straight from heaven, his work is such as to fill the visitor with admiration and envy.

—Ogilvie

Abstracts from Current Literature

Episiotomia Mediana. DaCosta, L. A. C., and Branco, J. P. C., Rev. de Ginec. e d' Obst., **102**:153, 1958.

Five hundred cases of midline episiotomy are analyzed as to results, 311 of the patients being primiparas and 189 multiparas. Forceps were applied in 66 cases. There were 6 breech presentations and 6 twin deliveries. Nineteen infants showed signs of prematurity. Sixty weighed more than 3,500 Gm. and 13 over 4,000 Gm. No. 00 chromic catgut was used exclusively for suturing. The skin was closed with intracuticular sutures. Complications that occurred early during the puerperium were: Dehiscence of the suture line (2 cases), unsatisfactory scar formation (12), lesions of the sphincter (5) and lesions of the rectum (3 cases). In all cases except 3, local anesthesia was employed.

ERNEST G. ABRAHAM, M.D.

Intracystic Carcinoma of the Breast. Gatchell, F. J., Dockerty, M. B., Glagett, O. T., Surg., Gynec. and Obst. **106**:347, 1958.

The authors present a series of 48 cases of intracystic carcinoma of the female breast. Nine thousand cases were studied. These cases of all types of breast cancer were encountered at the Mayo Clinic during the thirty-five years between 1920 and 1954. As far as the authors were able to determine from a careful study of both the gross and microscopic features of these tumors, they originated from, or near, the lining of the cysts that contained them.

Included in the series were examples of all 4 cytologic grades of malignancy.

The prognosis of tumors of this type is considerably better than that of the usual type of mammary carcinoma. The overall five-year survival rate in this series was 83.3 per cent.

These tumors are rare, the incidence at the Mayo Clinic being approximately 0.5 per cent. That they do occur, however, must be kept in mind when biopsy of a specimen from the breast is performed for supposedly benign cystic disease.

EDMUND LISSACK, M.D.

Severe Acute Urethritis Following Transurethral Prostatic Resection. Boyd, M. L., J. Urol. **79**:300, 1958.

Dr. Boyd describes the occurrence of 5 cases of acute urethritis and stricture formation following transurethral resection of the prostate.

The author discusses the many things that could be etiologic factors, such as irrigation solution, type of sheath, type of retention catheter, etc. and no conclusions as to the cause of the urethritis and stricture was reached.

SHEPARD JEROME, M.D.

On Plastic Middle Ear Operations, with Particular Attention to the Cavum Minor Technique. Richtnér, N. G., Acta oto-laryngol. **48**:302, 1957.

At the Söder Hospital, Stockholm, Richtnér performed plastic operations on 39 patients with chronic otitis media associated with chronic mastoiditis, attic or antra fistulas, etc. Some of the patients had cholesteatomas, and hearing was greatly impaired in all of them. Audiograms taken during the first 4 months after the operation showed that hearing had improved by more than 10 decibels in about half the cases. Seventeen patients were followed for twelve to eighteen months after the operation; in 9 of these, hearing was improved by an average of 25 decibels; 7 remained unaffected by the operation, and 1 became worse.

During the operation, and as after-treatment, tampons saturated with Ultracortenol proved useful for packing the radical cavities. The Ultracortenol exerted a clear-cut inhibitory effect on the formation of granulation tissue. In addition, the author is convinced that it has an anti-infectious effect. The ear that had undergone radical operation and the healed transplants healed well, and in almost all cases the tube remained open.

E. B.

The Fate of the Internal Mammary Artery Implant in the Ischemic Human Heart. Vineberg, A., and McMillan, G. C., Dis. of Chest, 33:64, 1958.

The internal mammary artery, implanted into the ischemic human heart, when ischemia was a result of coronary artery disease, remained open in 85.8 per cent of the 7 hearts studied.

Further, when the artery was examined eighteen months after implantation, it was not only open and branching but showed little intimal proliferation.

The clinical results of this investigation, in which 75 per cent of patients with coronary artery insufficiency were relieved of anginal pain after implantation of the internal mammary artery, corresponds to the known mammary-coronary anastomotic rate in experimental animals.

EDMUND LISSACK, M.D.

Thrombocytopenic Accidents with Hemorrhage After Quinidine Treatment. Perrin, P., Dauphin, G., and Dauphin, M., Presse Med. 22:481 (March) 1958.

On the basis of 1 personal observation of thrombocytopenic purpura caused by hypersensitivity to quinidine, the authors review this subject and discuss 28 cases from the world literature. The condition occurs predominantly in the female. It is characterized by the absence, in most cases, of an allergic or hemorrhagic history, and by the disorders of rhythm in mitral and hypertensive cardiopathies that justified treatment with quinidine. Significantly, such therapy had been carried out previously in practically all of these cases.

Purpura with gingival and nasal bleeding is typical, whereas visceral hemorrhages are not as frequently observed. Biologically the hemorrhagic accidents are the result of a secondary hemogenic syndrome (thrombopenia, delayed blood clotting, irretractility of the clot, etc.). The course of the condition is favorable with or without treatment as soon as the administration of quinidine is discontinued. The value of the test for intradermal reaction and the patch test, which are easily performed, is emphasized. Pathogenically, the hemorrhages are thought to be due to the existence of a panagglutinin acting on the platelets of the patient or on normal platelets only in the presence of quinidine. This agglution produces, simultaneously or successively, agglutination and lysis of the platelets.

E. G. A.

Observation On Survival of Patients Treated For Uterine Cancer. Scheffey, L. C., J.A.M.A. 166:1694, 1958.

Survival is not a synonym for comfort, and the statistics for five-year survival after treatment for carcinoma cannot reflect the vicissitudes of the individual patient.

Perseverance in the follow-up of such patients over a long period is necessary if the exact survival period is to be ascertained, in contradistinction to commonly estimated rates of survival.

In the final analysis, the clinician's problem remains threefold—prophylaxis, detection, management—and the uterus is a favored site for positive and definitive action. Prophylaxis can be practiced in spite of varied and sometimes contradictory etiologic and pathogenic concepts. The abnormal cervix can be managed with certainty, and atypical endometrial activity is readily subject to investigation.

The uterine cell test of Papanicolaou, skillfully utilized, can furnish prompt and valuable diagnostic leads from all areas of the uterus, and at times even from the adnexae. Subsequent critical evaluation and/or substantiation of positive or suggestive results from smear tests is mandatory, according to the discipline of cervical biopsies of various types and fractional uterine curettage.

Prophylaxis and prompt detection becomes the joint responsibility of very woman and her physician.

EDMUND LISSACK, M.D.

Aircraft Accident Injuries in the U. S. Air Force. Moseley, H. G., Colonel, USAF (MC), J. Aviation Med. 29:271, 1958 (April).

This paper is concerned with the phenomena of crash and trauma to the occupants of aircraft. During the calendar years 1953 and 1955 over 8,000 persons were involved in major U. S. Air Force aircraft accidents. Of

these occupants, 18.7 per cent were fatally injured and received fatal injuries and 5.2 per cent received major injuries; 76.1 per cent, however, received minor or no injuries. Most fatalities were caused by multiple traumatic lesions. Most major nonfatal lesions were fractures, especially of the vertebrae. Burns and surface wounds were frequent. The head and the distal third of the extremities received the majority of injuries and were associated with flailing of these unsecured body portions during deceleration. In accidents of the disintegrating type there is a high incidence of extreme injury, which is usually unpreventable because of the magnitude of the forces encountered. When impact forces in deceleration were moderate or negligible, there were few injuries; when impact was severe, injury was frequent and often fatal; when it was extreme, fatal results were the rule. In all accidents there was increased injury if the seat tore loose or if the seat belt was not used. If the occupant was in a seat facing the rear of the aircraft, he was less liable to be injured than if he faced forward. This was especially true in low impact accidents, in which the seat was more liable to remain moored to the floor.

ERNEST G. ABRAHAM, M.D.

Surgical Treatment of Cardiospasm. Ellis, F. H. Jr., Olsen, A. M., Holmand, C. B., and Code, C. F., J.A.M.A. 166:29, 1958.

The authors state that cardiospasm is a disease of unknown cause and might more properly be called achalasia of the esophagus. The disease consists of two distinct physiologic features, the first of which is failure of the lower esophageal sphincter to relax, and the second of which is the absence of effective waves of peristalsis in the esophagus. The condition is characterized by dysphagia and regurgitation. Roentgen studies and esophagoscopic studies may establish the presence of a dilated esophagus and the absence of any tumor.

Medical treatment plus mechanical dilation of the distal end of the esophagus achieves varying degrees of success. Approximately half of the patients so treated require periodic dilation, and in a certain number of these rather marked complications occurred, including 2 deaths.

Since it is impossible to change by surgical means the type of peristalsis in the esophagus, surgical attempts must be directed toward the sphincteric action in the distal end. The ultimate object of operation in these cases should be to allow the distal end of the esophagus to dilate sufficiently for emptying but at the same time to retain some mechanism that can prevent reflux esophagitis. The authors use a modified Heller procedure, which is described in detail. They prefer a thoracic approach. This procedure is not recommended for fibrous strictures of the distal portion of the esophagus. In general, the results have been so good and the complications so few that the authors recommended esophagomyotomy as the initial form of treatment for achalasia of the esophagus.

JAMES H. ERWIN, M.D.

Radical Panhysterectomy and Pelvic Node Excision for Carcinoma of the Corpus Uteri. Schwartz, A. E. Brunschwig, A.: Surg., Gynec. and Obst. 105: 675, 1957.

The author's study consisted of 96 cases of radical panhysterectomy or excision of a cervical stump combined with pelvic node dissection for endometrial carcinoma. The surgical and hospital mortality rate was 2 per cent. The incidence of fistulas of the urinary tract was 8 per cent.

The incidence of pelvic node metatases was 14 per cent.

In 37 cases followed for five or more years, the survival rate was 73 per cent.

Radical panhysterectomy with pelvic node excision would appear to be a logical operation for carcinoma of the body of the uterus.

EDMUND LISSACK, M.D.

Simple Mastectomy for Cancer of the Breast. Byrd, B. F., and Stephenson, S. E.. Jr., Ann. Surg. 145:807, 1957.

While there is still debate in some centers as to the application of simple mastectomy as a curative procedure, it is the authors' opinion that this limited operation is a palliative pro-

cedure and that cure should be sought through the more radical approach.

The technic of simple mastectomy is standard. The breast and the subjacent pectoral fascia are removed *en bloc*. The axilla is left undisturbed.

This study covers a period of thirty years. Every patient in this series has been followed to the time of his death.

Thirty-three patients have lived more than five years after the operation. Of these 8 have since died of carcinomas, and one is living after ten years, with recurrence. This gives an absolute five-year survival rate of 23.7 per cent.

When one rates a prolonged survival, and in some instances an apparent cure, then it can be believed that simple mastectomy has a definite role in the armamentarium of the surgeon who undertakes the management of patients with carcinoma of the breast.

EDMUND LISSACK, M.D.

Total Cystectomy: Analysis of 225 Cases from the Bladder Tumor Registry. Schwartz, J. W., Mostofi, F. K., Reed, J. F. Jr., and Dean, A. L., J. Urol. 78:41, 1957.

Two hundred and twenty-five cases of carcinoma of the bladder treated by cystectomy are reviewed. The cases were selected from cases of the Bladder Tumor Registry from the years 1931 to 1951.

Without restating all the statistics as to age, sex, symptoms and initial treatment, suffice it to say that the overall five-year survival rate was 17 per cent. Even though this percentage is low, it is much better than the survival rates reported for untreated patients in the same category.

SHEPARD JEROME, M.D.

The struggle medicine had waged so successfully against the forces of destruction during World War I was continued on an even grander scale during World War II. All the new methods for the treatment of infections, in the beginning with sulfadrugs, later with penicillin, the improvements in surgery and anesthesia, the use of blood transfusions, in its infancy in 1914, and of plasma, the possibility of moving the wounded from the battlefield were all brought into play. Behind this tremendous effort were two motivations: the humanitarian one of alleviating suffering, the utilitarian one of conserving manpower. Medicine again acquitted itself magnificently.

—*Farmer*

these occupants, 18.7 per cent were fatally injured and received fatal injuries and 5.2 per cent received major injuries; 76.1 per cent, however, received minor or no injuries. Most fatalities were caused by multiple traumatic lesions. Most major nonfatal lesions were fractures, especially of the vertebrae. Burns and surface wounds were frequent. The head and the distal third of the extremities received the majority of injuries and were associated with flailing of these unsecured body portions during deceleration. In accidents of the disintegrating type there is a high incidence of extreme injury, which is usually unpreventable because of the magnitude of the forces encountered. When impact forces in deceleration were moderate or negligible, there were few injuries; when impact was severe, injury was frequent and often fatal; when it was extreme, fatal results were the rule. In all accidents there was increased injury if the seat tore loose or if the seat belt was not used. If the occupant was in a seat facing the rear of the aircraft, he was less liable to be injured than if he faced forward. This was especially true in low impact accidents, in which the seat was more liable to remain moored to the floor.

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While there is still debate in some centers as to the application of simple mastectomy as a curative procedure, it is the authors' opinion that this limited operation is a palliative pro-

cedure and that cure should be sought through the more radical approach.

The technic of simple mastectomy is standard. The breast and the subjacent pectoral fascia are removed *en bloc*. The axilla is left undisturbed.

This study covers a period of thirty years. Every patient in this series has been followed to the time of his death.

Thirty-three patients have lived more than five years after the operation. Of these 8 have since died of carcinomas, and one is living after ten years, with recurrence. This gives an absolute five-year survival rate of 23.7 per cent.

When one rates a prolonged survival, and in some instances an apparent cure, then it can be believed that simple mastectomy has a definite role in the armamentarium of the surgeon who undertakes the management of patients with carcinoma of the breast.

EDMUND LISSACK, M.D.

Total Cystectomy: Analysis of 225 Cases from the Bladder Tumor Registry. Schwartz, J. W., Mostofi, F. K., Reed, J. F. Jr., and Dean, A. L., J. Urol. 78:41, 1957.

Two hundred and twenty-five cases of carcinoma of the bladder treated by cystectomy are reviewed. The cases were selected from cases of the Bladder Tumor Registry from the years 1931 to 1951.

Without restating all the statistics as to age, sex, symptoms and initial treatment, suffice it to say that the overall five-year survival rate was 17 per cent. Even though this percentage is low, it is much better than the survival rates reported for untreated patients in the same category.

SHEPARD JEROME, M.D.

The struggle medicine had waged so successfully against the forces of destruction during World War I was continued on an even grander scale during World War II. All the new methods for the treatment of infections, in the beginning with sulfadrugs, later with penicillin, the improvements in surgery and anesthesia, the use of blood transfusions, in its infancy in 1914, and of plasma, the possibility of moving the wounded from the battlefield were all brought into play. Behind this tremendous effort were two motivations: the humanitarian one of alleviating suffering, the utilitarian one of conserving manpower. Medicine again acquitted itself magnificently.

—Farmer

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